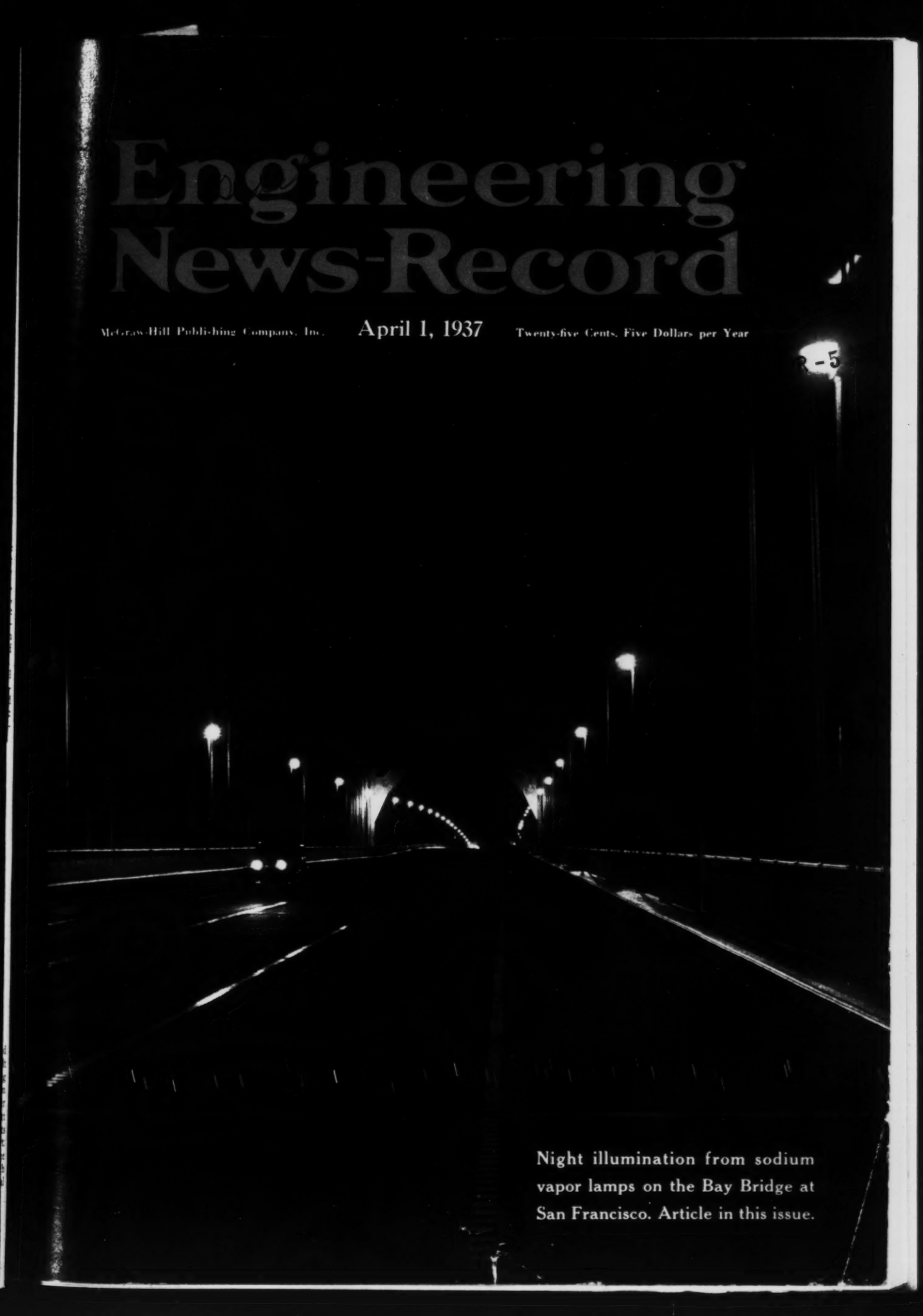
Engineering News-Record

McGraw-Hill Publishing Company, Inc. April 1, 1937 Twenty-five Cents. Five Dollars per Year



Night illumination from sodium vapor lamps on the Bay Bridge at San Francisco. Article in this issue.

Above: Soldier Field, Chicago's mammoth lake front stadium... In circle: One of ten ticket booths, all covered with galvanized Toncan Iron sheets.

REPUBLIC STEEL

REG U S PAT OFF

TONCAN

COPPER MO-LYB-DEN-UM IRON

HIGHEST RUST-RESISTANCE IN ITS PRICE CLASS

Republic Steel Corporation

GENERAL OFFICES . . . CLEVELAND, OHIO

Into the unceasing battle against the destructive forces of rust and corrosion march daily huge tonnages of Republic products. A leader in this parade of products is Toncan Copper Molybdenum Iron.

This conquering warrior is rust's nemesis. Where less sturdy materials fail, Toncan Iron battles on for years, winning many citations for reducing replacement costs.

The recent application of Toncan Iron for roof coverings on the ticket booths at Soldier Field, Chicago, was most appropriate — a soldier of good fortune for Soldier Field.

Other Republic products — sheets, plates, pipe, tubing, bars, bolts, nuts, rivets, turnbuckles, wire rope clips, nails and wire made of steel, copper-bearing steel and Toncan Iron — will help you in your battle against the elements that attack all types of structures. Write for literature and information.

"When writing Republic Steel Corporation (or Steel and Tubes, Inc.) for further information, please address Department EN."

Industrial Relations on the March

RECENT weeks have been making history in the field of industrial relations. Although it always is difficult to discern in the day's news those trends that eventually make history, it is worth while to look for them. Only as we do perceive them can we benefit from experience and hold our own affairs within the current of progress.

At this writing two impressions are paramount. One is the apparent triumph of lawlessness. Even public officials have chosen to ignore the moral and legal rights of their citizens and to evade their obligations. Minorities, trading on the reluctance of others to precipitate violence in defense of their legal rights, have dominated less aggressive majorities. Laws have been invoked when they served one's interest and ignored when they did not. By their reluctance to stand steadfast for law enforcement, public officials and the press have condoned such tactics. Thereby they have incited a widespread disrespect for law and authority that already is making itself felt.

All this is the seamy side. Its pattern is one of disorder and violence. It sacrifices the rights of the many to the aggression of a few. It flouts the principle of orderly adjustment within the framework of democracy. It rejects native procedure in favor of alien devices that play into the hands of minorities who would rule or ruin. Whatever local advantage anyone may derive from such tactics, they portend, in their logical conclusion, evil to all alike—employer and employee, government and unions and, most of all, the general public.

BUT there is another side. On the part of both industrialist and labor leader is emerging a new appreciation of long-term values. This does not imply that such vision is new to all. Many have applied it for years. But it does indicate a more widespread and sympathetic acceptance of new values, even in quarters that we have been accustomed to consider most hard boiled. It suggests a new recognition of industrial responsibility and a new appreciation of what constitutes social progress.

All this is the brighter side. Its pattern is the most effective answer to those who would incite lawlessness to nourish disorder and revolt. It helps to disarm the arrogant and destructive minority. It encourages respect for the democratic conduct of controversy and negotiation. It justifies the native American procedure and extends it to meet the changing needs of an industrial society. This trend, carried to its logical conclusion, will make for the general good.

If enlightened industry and responsible labor leadership will back that trend, it can become an effective antidote to the virus of lawlessness. What history eventually may write of these doings will depend on how capably that is done.

BUT the responsibility of labor leadership is vital. Back in 1934 this writer spoke of collective bargaining then under discussion in connection with NRA, as follows:

"Collective bargaining, or any other kind of bargaining, implies delivery as well as collection, giving as well as getting. To be successful any bargain must involve an equitable exchange of values; each party must feel that he is receiving a value comparable with that which he gives.

"Obviously, then, true bargaining must involve on both sides a faith in the ability as well as the willingness of the other to deliver the goods.

"It is quite possible that a major difficulty in this matter of collective bargaining is a doubt on the part of employers as to the ability of certain labor leaders to deliver. * * *

"If such bargaining is to be fruitful of industrial peace it must be conducted by parties that are, beyond a doubt, truly representative, responsible in the courts for their acts and agreements and just as effective when it comes to delivering their share of the bargain as they are in exacting the consideration due to them. * * *

"In this as in all other matters, power and responsibility should be inseparable."

If from the present turmoil there emerges a labor leadership able and willing to bargain with employers on such a basis, we shall have taken a long step toward the fortunate outcome so devoutly wished by every thoughtful American.

Willard Chevalier

ENGINEERING NEWS-RECORD Published every Thursday. Vol. 118, No. 13. Price 25c per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries, $9 a year or 36 shillings. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C.

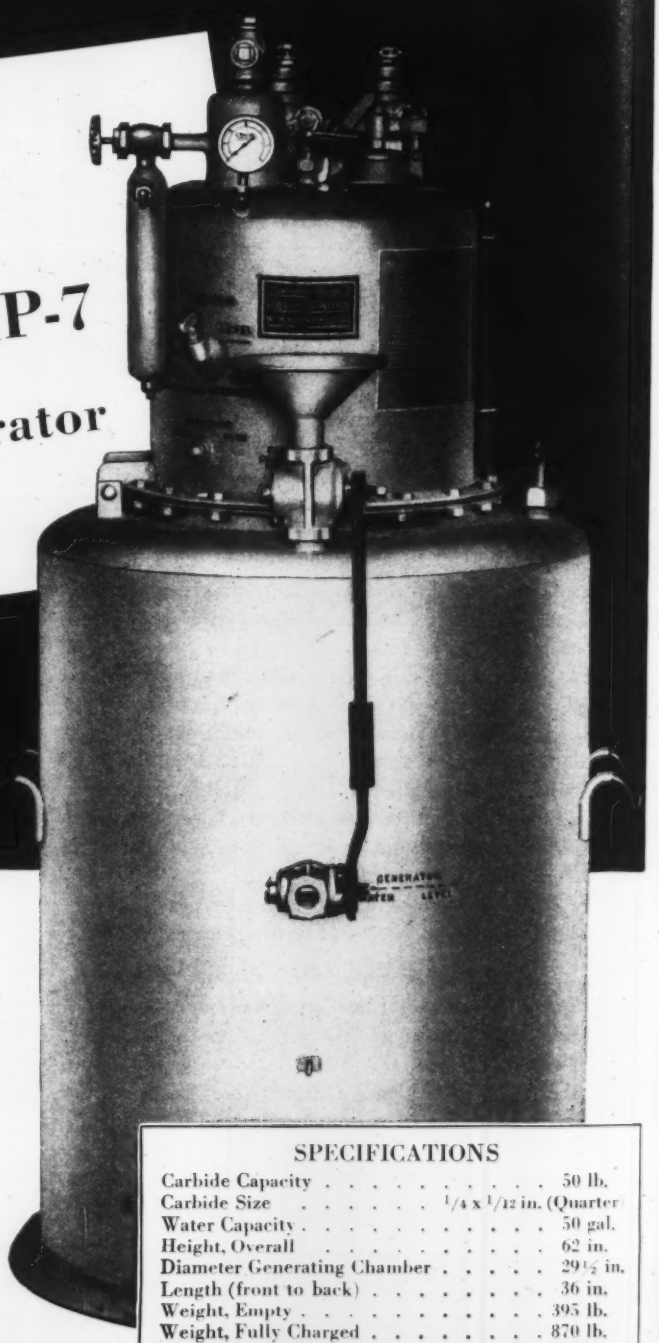
Copyright 1937 by McGRAW-HILL PUBLISHING COMPANY, INC.

Editorial and Executive Offices: 330 West 42d St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

JAMES H. McGRAW, JR., Chairman — MALCOLM MUIR, President — JAMES H. McGRAW, Honorary Chairman
WILLARD CHEVALIER, Vice President — B. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary

Table of Contents — See page 33

Announcing
The Oxweld MP-7
Acetylene Generator



This new Oxweld generator will operate any number or type of oxy-acetylene welding or cutting blowpipes requiring up to 100 cubic feet of acetylene per hour. It will maintain constant pressure on the acetylene line; hence no additional regulator is needed with the MP-7.

The Oxweld MP-7 Acetylene Generator is of the medium-pressure type for portable or stationary use. It is simple and economical to operate. Its all-welded steel housing makes it especially rugged and dependable. The MP-7 is listed as standard by Underwriters' Laboratories, Inc.

Write for a descriptive folder. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.

SPECIFICATIONS

Carbide Capacity	50 lb.
Carbide Size	1/4 x 1/12 in. (Quarter
Water Capacity	50 gal.
Height, Overall	62 in.
Diameter Generating Chamber	29½ in.
Length (front to back)	36 in.
Weight, Empty	395 lb.
Weight, Fully Charged	870 lb.
Weight, Shipping	560 lb.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES FROM UCC LINDE UNION CARBIDE

ENGINEERING NEWS-RECORD

McGraw-Hill Publishing Co., Inc.

Editorial and Executive Offices: 330 West 42d St., New York Publishing Office: 99-129 No. Broadway, Albany, N. Y.

Editorial Staff
V. T. Boughton
W. G. Bowman

Chicago
W. W. DeBerard

F. E. Schmitt, *Editor* Willard Chevalier, *Vice-President*

Editorial Staff
C. S. Hill
H. W. Richardson
E. J. Cleary

San Francisco
N. A. Bowers

Volume 118 Number 13 Copyright 1937

April 1, 1937

Sodium Vapor Lighting on Bay Bridge 467
C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff

Purlins and Girts as Catenaries ..... *Robins Fleming* 470

Pavement Design and Construction ..... *E. F. Campbell* 471

Drainage Basin Problems and Program ..... *Abel Wolman* 476

Santa Clara Valley Subsidence ..... *E. E. Stohsner* 479

Determining Evaporation Losses ..... *Adolph F. Meyer and A. S. Levens* 481

Light Aggregate in Concrete Construction ..... *Ralph S. McLean* 484

Research Planned at A.R.E.A. Meeting 486

Driving Wakefield Pile Cutoffs 489

Letters to the Editor 490
Editorials 492
Current News 494
Business Side of Construction 500

■

Man of Destiny in the biggest job today—building better cities—is the city engineer. Part planner, part administrator, and part technician, he combines qualities that call for vision and versatility. The man, his work and his problems are featured in the special City Engineering Issue scheduled for April 29.

GEORGE HAS ALL THE ANSWERS

George Bentley is an up-and-coming member of our mailing department.

George and his mates have charge of mailing of the reams of concrete information available here. Right at their fingertips is the answer to just about every question on the subject of concrete.

Booklets . . . pamphlets . . . circulars . . . prepared by practical cement men—all available to you on request. And if you ask for something that requires special work on our part to dig out the answer, we're glad to do that too.

Not that we're trying to pose as "know-it-alls" in the cement business. We simply want you to know that there's a whale of a lot of good practical concrete information available at Universal Atlas, without charge, whenever or wherever you need it. This is part of our service—a service we try to improve on all the time.

UNIVERSAL ATLAS CEMENT CO.
208 South La Salle Street, Chicago

United States Steel — Corporation Subsidiary

New York • Cleveland • Philadelphia • Albany
Boston • St. Louis • Des Moines • Birmingham
Waco • Kansas City • Pittsburgh • Duluth • Minneapolis

G-4

Universal Atlas
CEMENTS

ENGINEERING NEWS-RECORD
April 1, 1937

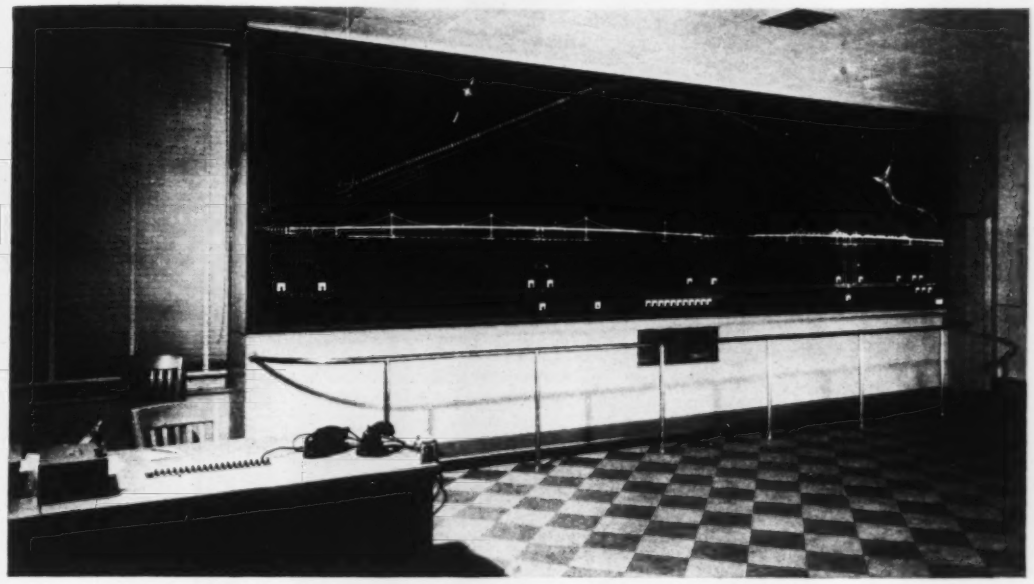


FIG. 1—CONTROL OFFICE in the administration building. Roadway lights, navigation and aviation signals are duplicated on the control board.

Sodium Vapor Lighting On The San Francisco Bay Bridge

By C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff
Respectively Chief Engineer, Bridge Engineer and Engineer of Design, San Francisco-Oakland Bay Bridge

ILLUMINATION on the San Francisco-Oakland Bay Bridge is accomplished by high-mounted, sodium vapor lighting units on a relatively close spacing. In several respects the installation departs from common practice because it was believed necessary to find means of improving roadway lighting, particularly in obtaining more uniform illumination and reducing glare from the lighting units as well as from the headlights of approaching cars. If it meets these requirements, even in some degree, the lighting system on the Bay Bridge will be an important factor in keeping accidents to a minimum on this portion of the state highway system.

Including upper and lower decks and approaches, the bridge has 18.3 miles of lighted roadways. On the upper deck, the luminaires are placed opposite at intervals of 150 ft. On the lower deck, which has railway tracks as well as roadway, the lights are placed on one side of the roadway only, and the spacing is 120 ft.

At the east or Oakland end of the bridge, east of the toll plaza, double units are used and the luminaires are set in a parked dividing strip which separates the opposite directions of traffic. At the Fifth St. plaza, the toll plaza and the San Pablo underpass, conventional incandescent lighting was used to remove possible objections to the monochromatic sodium vapor light. In all, there are 1077 sodium vapor lights of 10,000-lumen size and 90 incandescent lights of 10,000-and 15,000-lumen size on the bridge decks and the approaches.

Distribution system

In order to minimize the probability of service interruptions for the roadway lighting and especially for the navigation signals, two supply stations are provided, one at the San Francisco anchorage and the other at the administration building on the Oakland approach, each with an independent source of energy. At these points current is supplied by the Pacific Gas and Electric Co. and is stepped down to 2400/4160 volts by three 150-kva., single-phase, 60-cycle, oil-insulated, air-cooled transformers.

From these sources current is distributed to six substations (Fig. 2), located (1) at the San Francisco anchorage, (2) central anchorage, (3) Yerba Buena anchorage, (4) pier E-4, (5) administration building and (6) distribution structure. A distribution cable connects the two supply stations, passing through each substation, except No. 6, and is sectionalized at each end of the five substations by oil circuit breakers; the substation load is connected between the two breakers. This arrangement permits the entire system to be fed from either of the supply stations. Normally the breaker at the east end of substation 3 is open, so that three substations are connected to each supply station. This breaker, solenoid-operated, is controlled from the administration building. In the event of open or short circuit at any point, the closing of this breaker restores service up to the point of trouble.

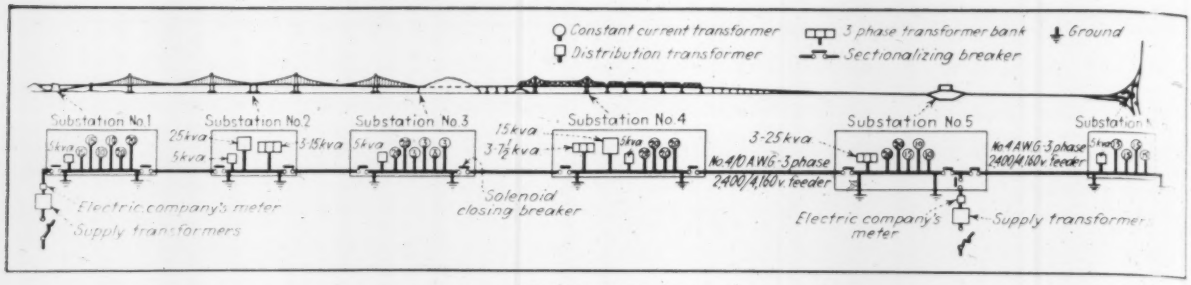


FIG. 2—SUBSTATIONS, at six points on the bridge, with interlocking connections, localize short circuits and utilize two independent energy sources.

Each circuit breaker is equipped with a lock-out coil so that at least one breaker in the system must be open at all times to prevent the possibility of tying in the two sources of supply. Each adjacent pair of breakers is so interlocked by overcurrent relays equipped with front and back contacts that any excess overload passing through both breakers will not trip the breaker nearer the source of supply. Thus only the breaker immediately back of the fault will trip. The operator then may trip out the breaker on the opposite end of the faulty section, and by closing the solenoid-operated breaker restore service to the sections beyond the fault. All tripping is done by 24-volts d.c. from a local battery floated on the line by a copper-oxide rectifier.

The circuits to the luminaires, to navigation and aviation signals and to power units radiate from each of the substations. The roadway lighting is supplied by 6.6-amp. series circuits through constant current regulators with individual transformers at each lamp. The circuits are so arranged that half lighting is possible, resulting in 150 ft. alternate spacing on the upper deck and 240 ft. on the lower deck.

The sodium vapor luminaires are of the open type using a specially polished aluminum with "Alzac" treatment for reflector surfaces. Reflectors are of parabolic shape with auxiliary plane reflectors. The units are mounted 25 ft. above the pavement on the upper deck and 19 ft. above the lower deck; the latter height is restricted by the upper deck construction. Steel standards for the upper deck are of a plain octagonal section except that on the cantilever bridge and the 504-ft. spans of the East Bay crossing the luminaires are mounted on brackets from the steelwork. On the lower decks the luminaires are mounted on the bridge structure while in the Yerba Buena tunnel they are supported on brackets set in the concrete lining.

The combination of the sodium vapor lamp, with its reflector, mounting height and spacing has resulted in a high efficiency, the average lumens per foot being 133.3 which produce an average intensity at the roadway of 0.84 foot candles. With full lighting the illumination is very uniform, there is no glare from the roadway lighting and that from opposing headlights is materially reduced. The non-glare from the light units results from the large surface from which the light emanates. The glare from opposing headlights is largely eliminated by the high general level of illumination.

FIG. 3—SIX-LANE UPPER DECK of the bridge illuminated with sodium vapor lamps set 25 ft. above the pavement and 150 ft. apart. Standards are opposite.

Aviation and navigation signals

Five navigation channels in the West Bay and four in the East Bay are marked with the conventional channel and pier lights; the circuits are controlled by telechron time clocks with astronomic dials. The pier lights adjacent to the channels where water traffic is heaviest are supplemented by white lights spaced at 20-ft. intervals around the fenders.

Piers adjacent to each of these channels are protected by fog signals including six double-head, coded sirens, each driven by a 10-hp. motor, and five bells. The fog signals are operated from the administration building with a coder for each group located in the substations where the transformers are located. Each blast of each siren and each stroke of each bell is indicated separately on the control board by the flashing of a light located at the proper point on the diagram.

The tops of the bridge towers are provided with 1000-watt revolving airway obstruction beacons, with 24-in. red lenses and red zenith panels. The four beacons in the West Bay are synchronized so their beams always point in a common direction. The two on the tops of cantilever towers in the East Bay are similarly connected but do not rotate in synchronism with those in the West Bay. At the center of the 504-ft. truss spans are five 300-mm. flashing code beacons (three seconds on and two seconds off) mounted on the top chord bracing. These are fed from the same branch circuits that control the navigation lights. Each individual navigation and aviation light is separately indicated on the control board.

Control board

The control and indicater board is the showpiece of the electrical installation. It is located in the room just off

the main lobby in the administration building where all electrical controls center. Fabricated from "black-on-white" micarta, it is 25 ft. long and covers one side of the room to the ceiling. Across the lower half of the board is a design, drawn to scale, showing almost the entire bridge structure in elevation. At the proper point, indicator lights with ⅛-in. colored caps are inserted to show the operation of the equipment located there.

Below this elevation is shown the feeder connecting the substations, the indicators and the control switches for each substation breaker, the indicators for each transformer switch and in the center the group of switches that control the roadway lighting regulators. Under the proper substations are located the switches and indicators for the two fog signal circuits.

At the top of the board is a plan of the entire project, showing all of the approaches and the connecting roadways on each end. All of the roadway lighting circuits are indicated on this plan, each pair of indication circuits covering the same area on the plan that the circuit covers on the roadway. These indication circuits are from current indicating relays. Lamps in each area on the board are connected so the operator can tell at a glance the condition of each circuit. This indication of both switch and current also gives a double check on circuit operation. Conventional colors are used, red for "on" and green for "off," except that the indication on the roadway lights is amber for sodium vapor and white for incandescent luminaires.

The design was sandblasted through the outer black face of the panels into the white layer underneath. It therefore is permanent and the panel can be cleaned without danger of erasing or defacing. Should the white background eventually become soiled, the contrast can be restored by painting in the bottom of the grooves.

Electrical cables on the steel structures are protected by being encased in bronze, interlocked armor. Similar cable, with an additional outside protection of impregnated jute, was used in the approach fills, where it was buried in trenches. Conduit was installed through concrete structures and also for vertical runs in steel structures. In these cases, a heavy cotton braid was substituted for the bronze armor. This armored cable on steel structure has been further protected by three coats of paint.

All control and indication is handled by direct current circuits through a separate control cable of 166 conductors. Except for the core which consists of seven No. 8 A.w.g. conductors, the cable is made up of sixteen No. 16 A.w.g. conductors. All conductors are stranded and insulated with 30 per cent class *AO* rubber compound. The cable is stepped to smaller sizes by eliminating layers of wires, thus obtaining sizes of 166, 119, 78 and 43 conductors. The outer protection is the same as for all other wires and cables in similar locations. Control circuits operate at 96 volts and all indication at 48 volts through telephone type relays at the board. The actual indication is made by 24-volt, telephone-type lamps behind ⅛-in. lamp caps of various colors.

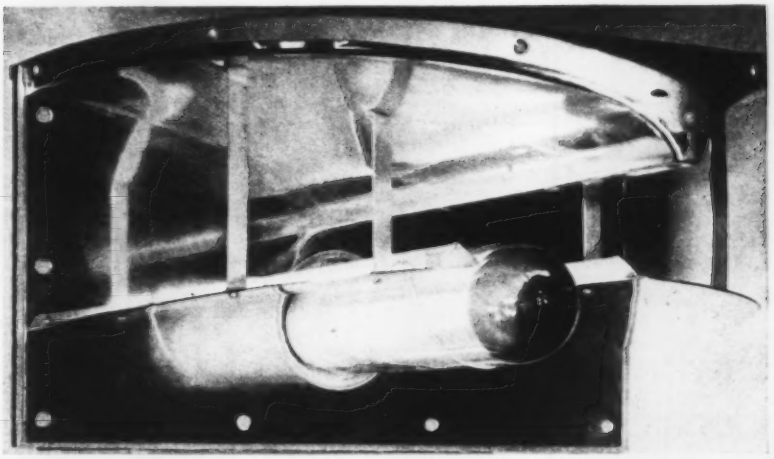


FIG. 5—LUMINAIRES used on the Bay Bridge are filled with sodium vapor and each gives 10,000 lumens without glare. Reflecting surfaces, both plane and parabolic, are of aluminum.

The electrical installation includes a police type telephone system connecting police call boxes at various points along the structure and approaches and at the electric substations. This system centers at a switch board independent of the outside telephone service, on the desk sergeant's table in the administration building. There has been provided also an independent fire alarm system with call boxes at intervals along the bridge roadways. Each box has two levers, one calling for fire apparatus, the other for towing service. This same system is connected through auxiliary boxes on each end of the bridge so that the fire departments of San Francisco and Oakland may be called in cases where the bridge fire department needs outside help.

The cost of the complete electrical

FIG. 4—DOUBLE LUMINAIRES set on tapered steel shaft are placed in two rows between the roadway lanes on the Oakland mole fill. Administration building and toll plaza are illuminated by incandescent units.

installation, excepting signs and devices in connection with toll collection, was $550,000. The annual maintenance and operating costs are estimated as $15,000 for current, $10,000 for lamp renewals, and $15,000 for labor and miscellaneous materials. For incandescent lights the current would have cost $35,000, lamp replacements $5,000, so that an annual saving of $15,000 is indicated in favor of the sodium lighting.

The contract for the electrical work on the bridge was held by the Alta Electric and Mechanical Co., Inc., and American Building Maintenance Co.; Thomas Bennett was in charge of installation. Details of the design were developed by Henry Tilson and C. R. Davis, senior electrical engineers on the Bay Bridge; the former acted as resident engineer during construction. The personnel of the California Toll Bridge Authority was given in *ENR* Mar. 22, 1934, p. 377.

Purlins and Girts in Mill Buildings Considered as Catenaries

By Robins Fleming

American Bridge Co., New York, N. Y.

THE end and side girts of mill buildings often present a design problem. Many are now standing that have no right to be. An article, "Light Corrugated Iron Roofs and Sheds" by S. McConnell in the British *Civil Engineering* of July, 1935 says that many cases are known in practice where purlins designed as simply supported spans with a maximum stress of 8 tons (1 ton = 2240 lb.) per sq.in., increased 33⅓ per cent for wind, are capable of carrying only 4.5 lb. per sq.ft. The present writer knows of side and end girts of 3½x2½-in. angles 16 to 20 ft. long spaced 4 to 5 ft. apart that have seen 20 years service. In scores of cases girts, if figured for the wind pressure usually specified and as beams simply supported at the ends, have maximum fiber stresses of 35,000 to 40,000 lb. per sq.in.

A reason often given for this defiance of good practice is that the load assigned to such cases has never come upon them. Another reason sometimes given is that before collapsing they will act as catenaries. In a specification before the writer is a sentence, "Purlins, girts, etc., shall be figured as beams, not as catenaries."

It is proposed to consider the girt as a catenary, or more correctly as a parabola. A cable betwen two fixed points hanging freely under its own weight will assume the form of a catenary. If carrying a distributed load of constant horizontal intensity it will assume the form of a parabola. As far as the structural engineer is concerned there is no appreciable difference between the properties of the catenary and those of the parabola. Steinman, in his book "Suspension Bridges," says, "If the sag-ratios are small, all the formulas for the catenary may be replaced, with sufficient accuracy, by the formulas for parabolic cables." Godfrey in his "Tables" gives numerical comparisons of the lengths of the two curves. For a span of 100 ft. and sag of 5 ft. the length of the catenary is 100.6636 ft. and of the parabola 100.6627 ft. For a sag of 3 ft. in a span of 100 ft. the length of each curve is given as 100.2376 ft. It should be noted that a deflected beam takes the form of a parabola.

An approximate equation for the length, l, of a parabolic curve of span L between two fixed points at equal elevations for a sag-ratio n (sag d at center divided by L) is $l = L(1 + 8/3n^2)$ or (since $n = d/L$), $l = L(1 + 8/3\frac{d^2}{L^2})$. Frankland in his book "Suspension Bridges of Short Spans," says that this equation is true to within one-quarter of one per cent.

The method of calculation that follows is that of C. M. Goodrich, chief engineer, The Canadian Bridge Co., Ltd., Walkerville, Ontario. The sides of a building are covered with corrugated steel on 4x3x¼-in. angle girts spaced 5 ft. apart. The 4-in. legs are horizontal. The bays are 20 ft. and wind pressure is assumed at 15 lb. per sq.ft. of exposed surface. A single girt thus carries a load of $15 \times 20 \times 5 = 1500$ lb. The handbook gives the sectional area of the angle as 1.69 sq.in., the moment of inertia, I, as 2.8; the distances of the neutral axis from the outer fibers, $c = 2.76$ in. and $c_1 = 1.24$ in. E will be assumed as 30,000,000. It is assumed that there is no side movement of the column and no slip in the bolts. The girts are considered fastened but not fixed at ends.

Bending moment at center:

$$M = \frac{1500 \times 20 \times 12}{8} = 45{,}000 \text{ in.-lb.}$$

Deflection at center: $d = (5/384)\left(\frac{Wl^3}{EI}\right) = (5/384)\left(\frac{1500 \times 240^3}{30{,}000{,}000 \times 2.8}\right) = 3.21$ in.

Fiber stress $f = \frac{Mc}{I}$ or $\frac{Mc_1}{I} = \frac{45{,}000 \times 2.76 \text{ or } 1.24}{2.8} = 44{,}350$ lb. per sq.in. tension and 19,930 lb. per sq.in. compression.

After bending, the unit elongation or strain $= 8/3L\left(\frac{d^2}{L^2}\right) \div L = 8/3\frac{d^2}{L^2}$.

The unit stress = unit strain $\times E = 8/3 \times \frac{3.21^2}{240^2} \times 30{,}000{,}000 = 14{,}300$ lb. per sq.in.

The stress in the angle is $14{,}300 \times 1.69 = 24{,}170$ lb. and its moment is $24{,}170 \times 3.21 = 77{,}580$ in.-lb.

It is noted that in considering the action of the girt as a simple beam the stress varies directly as the deflection; in considering the action of the girt in tension only (like a wire rope) the stress varies as the cube of the deflection.

If the ratio of the actual load of 1500 lb. to the load required to maintain the sag of 3.21 in. (with position-fixed ends) is k, then the total moment of 45,000 in.-lb. needed to carry the load of $1{,}500 = k \times 45{,}000$ (the simple beam moment) $+ k^3 \times 77{,}580$ in.-lb. (the resisting moment exerted by the axial force).

$k^3 + 0.58k = 0.58$
so that $k = 0.61$
$45{,}000 \times 0.61 = 27{,}450$
$77{,}580 \times 0.61^3 = 17{,}610$
45,060 in. lb.,

which is the moment carried.

When bending,

$$\text{tension} = \frac{27{,}450}{45{,}060} \times 44{,}350 = +27{,}010 \text{ lb. per sq.in.}$$

$$\text{Arm } (d) = \frac{27{,}450}{45{,}060} \times 3.21 = 1.95 \text{ in.}$$

As parabola,

$$\text{tension} = \frac{17{,}610}{1.95} \times \frac{1}{1.69} = +5340 \text{ lb. per sq.in.}$$

$27{,}010 + 5340 = 32{,}350$ lb. per sq.in., which is the total tension.

When bending,

$$\text{compression} = \frac{27{,}450}{45{,}060} \times 19{,}930 = -12{,}140 \text{ lb. per sq.in.}$$

and $-12{,}140 + 5340 = -6800$ lb. per sq.in. which is the total compression.

The stress or horizontal pull at each end $= \frac{17{,}610}{1.95} = 9000$ lb. Two bolts are thus required for fastening the girt to the column.

If wind pressure were assumed at 20 lb. per sq.ft., as by Mr. Goodrich in his illustrative example, the tensile stress + 32,850 would be +38,600 and the compressive stress — 6850 would be —6900. The horizontal pull at each end would be 12,260. If wind pressure were assumed at 10 lb. per sq.ft., the stresses would be +24,510 lb. per sq.in. and —6,250 lb. per sq.in. respectively. The horizontal pull at each end to be taken by bolts would be 5,540 lb.

Pavement Design and Construction In Minneapolis

New paving now of three general types, asphaltic concrete, cement concrete and brick—Eight types in old and new pavement totaling over 7,500,000 sq. yd.—Technique of present construction and maintenance operations highly developed.

By E. F. Campbell
Superintendent of Pavements, Minneapolis, Minn.

WITH THE ORGANIZATION and plant described in the preceding article (ENR, Mar. 25, p. 437) the paving department of Minneapolis constructed in 1936, 383,-163 sq. yd. of four types of paving and built 79,497 lin. feet of curb and gutter. As in all large cities there remain in Minneapolis stretches of outmoded old pavement types; in this article these are ignored and description, except for some maintenance figures, is confined to present-used designs and construction practices. Again where processes and equipment are current and familiar it is assumed that mention is sufficient for understanding.

In general current paving is either asphaltic concrete, cement concrete or brick; this statement applies to resurfacing as well as to new pavement, but most of the resurfacing is with asphaltic concrete, and this material has been highly developed.

Asphaltic concrete

The normal weight and percentage proportions of the various asphalt mixes used are given in Table I and typical asphaltic concrete pavement sections are shown by Fig. 1.

Materials—The city acquired its first asphalt plant in 1913 for resurfacing the old sandstone, granite and brick pavements then in use. The first mixtures were of the Topeka type, or stone-filled sheet asphalt which relied on the grading of the sand, percentage of bitumen and consistency of the asphalt for stability. Since 1920 all bituminous pavements have been asphaltic-concrete. While the streets resurfaced in the early years between 1913 and 1920 are still in use, they are not as smooth as the streets paved with the present mixture. Because of the success of this latter type since its inception, very little change has been made in the fundamental design of the mixture as is illustrated by the comparison of composite bin gradings in Table II.

Although the basic design remains the same, changes have been made in

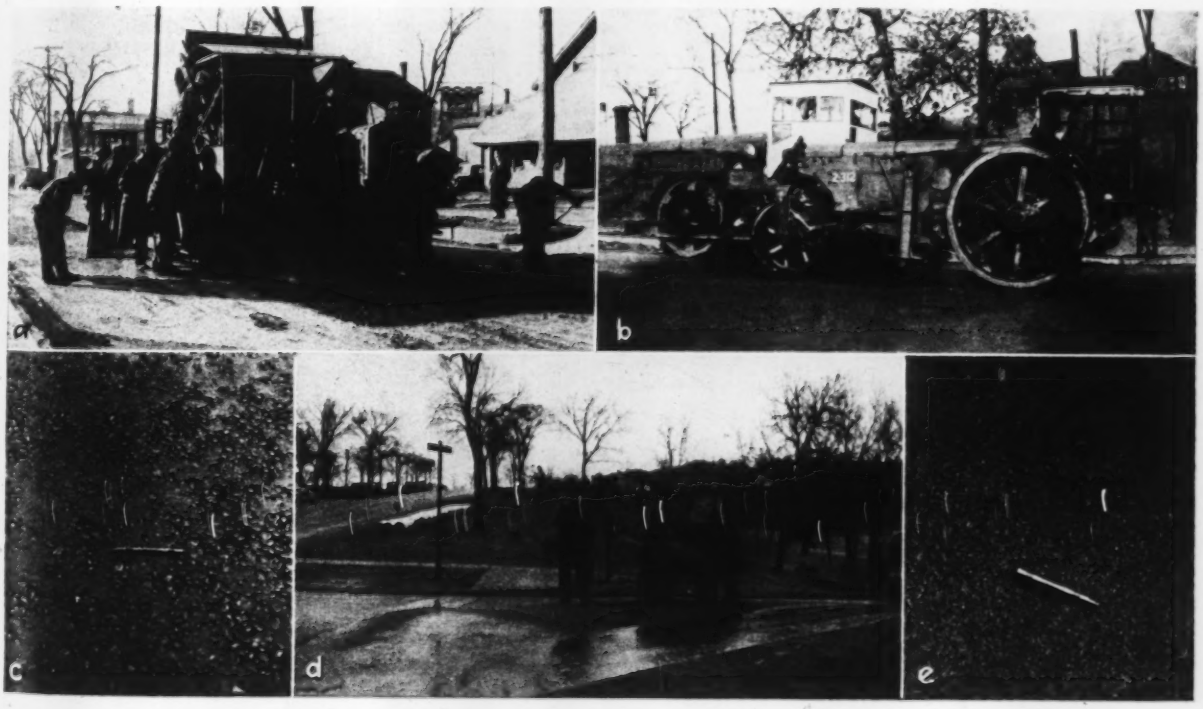


FIG. 1 — MINNEAPOLIS is getting smoothness and non-skid properties into asphaltic concrete streets by refinement in construction processes. (a) Mechanical spreading (b) Rollaplane rolling (c) Ready for seal coat (d) Seal coat spraying (e) Finished.

FIG. 3—CONCRETE paving practice emphasizes surface evenness and skid resisting surface. (a) Finishing machine (b) Floating and templating (c) Broom finishing (d) Surface texture and lane marker.

the character of the aggregates and more stringent gradation requirements introduced. Considerable experimentation and study has also been given to asphalt cement that will meet the requirements of the prevailing climate.

Methods—When asphaltic concrete replaces worn-out wood-block paving, the old surface and cushion are removed. The wood blocks are either salvaged for the repair of other wood-block streets or given away to the needy for fuel. Then the base is thoroughly cleaned and flushed; prior to placing asphaltic materials it receives a final sweeping.

The original wood blocks were either 3½ or 4 in. thick and were laid on a sand cushion 1 to 1½ in. thick; thus from 4½ to 5½ in. of asphaltic-concrete resurfacing is required to bring the street to its original grade and crown. The leveling or binder course is laid on the cleaned base sufficiently thick to bring the street to a grade and crown 2 in. below the desired finished grade. Where more than 3 in. of binder are required, it is laid in layers not to exceed 3 in. thick so as to insure uniform compaction. The binder course is usually laid by hand methods and care is taken to see that the surface of this course is uniformly smooth. Upon this binder the asphaltic-concrete wearing course is laid by mechanical bituminous pavers (Fig. 1) to a compacted thickness of 2 in. The specific gravity of the compacted surface averages 2.54 with a percentage of voids of about 1.5.

Mechanical placing has been used during the past two seasons; it was adopted in preference to hand raking mainly to improve the riding qualities of the pavement. A saving in cost has also been effected, and the quality of the pavement improved further by the elimination of segregation unavoidable in hand raking. Mechanical placing allows the handling of the asphaltic concrete at lower temperatures reducing the oxidation of the asphalt cement and giving a heavier coating on the aggregates.

On all newly constructed bases with asphaltic-concrete surfacing, the compacted thickness of the surface is uniformly 2½ in. and mechanical placing is also used.

The final operation in asphaltic-concrete paving is placing the seal coat. This is done by applying a coat of either asphalt emulsion or cut-back asphalt, spreading trap rock chips and rolling. In the past, bituminous material for seal coat was applied by squeegees or squeegee carts. One disadvantage of this method was that the film of asphalt was too thin and did not hold a sufficient amount of the chips. The use of the squeegee also gave the street the appearance of being brush-marked due to the lapping of joints. The practice now is to use a small pressure distributor (Fig. 1) to apply the emulsified asphalt or cut-back asphalt. The

nozzle is held high enough so that the material falls as a fine rain. Uniformity of coating is obtained by this method and any desired degree of thickness. Special dust-free trap-rock chips, 100 per cent of which pass the $\frac{3}{8}$ in. sieve, and not more than 5 per cent pass the No. 10 sieve, are spread by hand to a uniform thickness. A 12-ton 3-wheel roller is used to imbed the chips. This results in a surface with a sand-paper finish (Fig. 1) having excellent non-skid properties. Due to the durability of the trap rock chips the surface retains its non-skid properties for many years.

Cement-concrete paving

Many refinements in design, control and construction have been instituted since the first concrete pavement was laid in Minneapolis in 1912. Early pavements in this city, as elsewhere, were constructed with scant attention to the details which are considered essential today. The paving department in its present construction utilizes the latest methods and equipment. To illustrate these practices, a brief description of the methods used follows:

Materials—Minneapolis has available an abundant supply of good gravel within the city and in its immediate vicinity. Aggregates for concrete pavements undergo a rigid inspection at the material source where tests are made for quality and gradation. After the aggregates have been approved, they are hauled to the proportioning plants located adjacent to the work under construction. Considerable care is taken to construct the stock piles in such a manner that the least amount of segregation will take place. A clam shell moves the aggregate from the stock piles to the batching bins. Frequent moisture tests are made and dry-batch weights are adjusted accordingly. Fine and coarse aggregates are weighed into trucks in the proper proportions, cement is added and the batches hauled to the mixer.

Methods—The mixer is equipped with a long boom to enable it to operate outside of the forms and because the mixer does not move on the subgrade it is possible to complete fine grading and install steel and joint assemblies considerably in advance of the paving operations. The paving department has a finishing machine which is adjustable and can be used on streets of varying widths. Following the finishing machine (Fig. 3) a longitudinal float and straight-edges are used. The surface of the pavement is then belted and finally broomed. Slump tests are made at frequent intervals, and two 6 x 6 x 30-in. beams are made each day. The pavement is cured for 72 hr. by wet burlap and is normally kept closed to traffic for at least ten days and then it is not opened until the required

FIG. 4—BRICK PAVING in Minneapolis includes all the recent improvements in materials and methods. (a) Laying roadway brick (b) Laying brick track headers (c) Spraying non-bond fluid (d) Removing surplus filler.

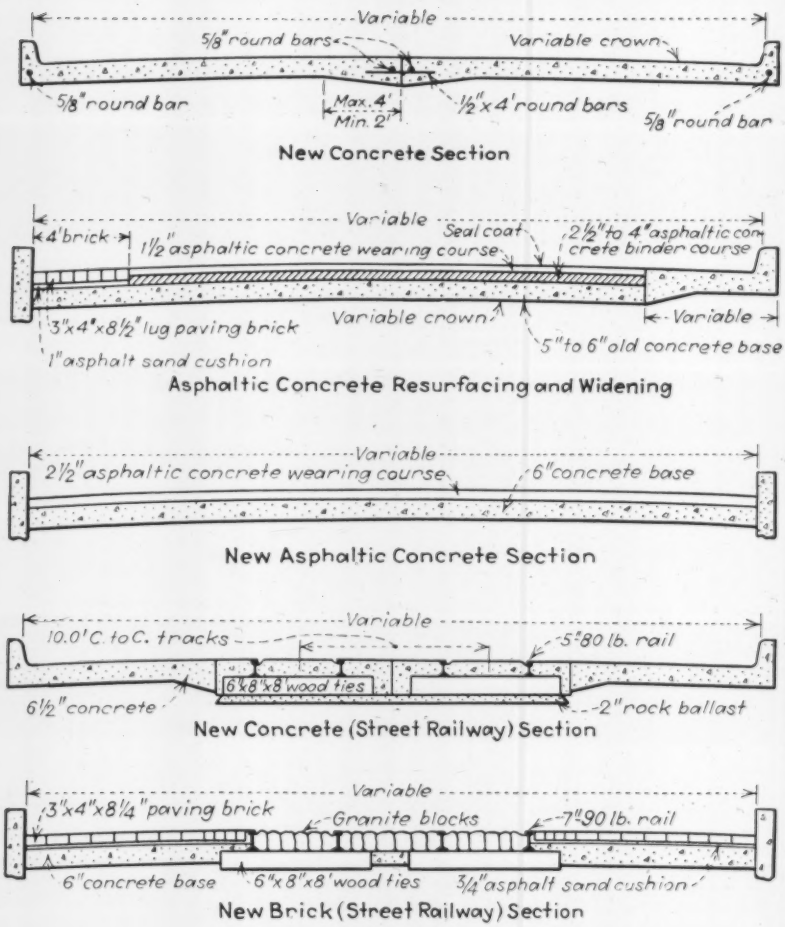


FIG. 5—TYPICAL PAVEMENT SECTIONS for newly paved and resurfaced Minneapolis streets without and with car tracks.

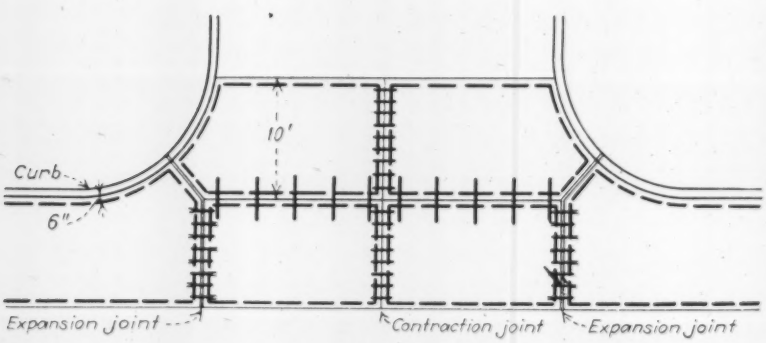


FIG. 6—POURED EXPANSION JOINT with dowels for concrete pavement.

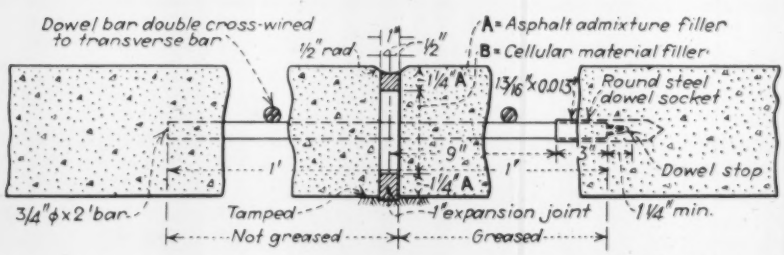


FIG. 7—INTERSECTIONS in concrete pavements are paneled by expansion and contraction joints.

strength, as represented by a modulus of rupture of 600 lb. per sq. in. on the beams, is attained. At important intersections and areas where it is necessary to open the pavement as soon as possible, high-early-strength mixes are used to shorten the period in which the street is closed.

Design—The general design of concrete pavement is shown by the typical section on Fig. 5. The 1 in. expansion joints (Fig. 7) are placed at regular intervals not exceeding 90 ft. and the maximum spacing of contraction joints is 30 ft. Special panel construction (Fig. 6) is often necessary at street intersections. The street is divided longitudinally by contraction and construction joints into panels or traffic lanes not exceeding 10 ft. in width. Marginal steel is used at the edges of the slab and at joints. The dowel steel spacing in expansion and contraction joints does not exceed 12 in.; expansion joints are poured or premolded and all joints are cleaned, filled and sealed immediately following the curing period.

The same standards of inspection of materials apply to curb and gutter, sidewalk, alley and base construction. Proportioning is done by weight on all concrete construction except alley paving where volumetric batching is used.

Brick paving

Many of the brick pavements now in use in the city were constructed over 20 years ago. The first brick pavement laid in 1898 is still carrying traffic on one of the important downtown streets. These old pavements were laid on sand or sand-cement cushion and either pitch or sand-cement grout filler was used. In general they have proved very satisfactory and maintenance has been due mostly to service cuts and sand-cushion trouble.

Design—Today, 3 x 4 x 8½-in. vertical-fibre lug brick is laid flat on a bituminous mastic cushion and sealed with an asphalt filler (Fig. 4). Where the concrete base is uneven a leveling course of asphaltic concrete binder is used so that a uniform thickness of mastic cushion can be placed under the brick. This is very important for the smoothness of the finished surface depends a great deal upon the uniformity of thickness of the cushion.

Brick gutters from 4 to 6 ft. wide are used on asphaltic-concrete pavements where continuous parking along the curbs prevails. Brick street-car track headers (Fig. 5) are also built to a width of 20 in. to enable the street railway company's crews to make repairs to the tracks and ties without having to disturb the pavement outside of the ties.

Methods—The brick is placed in transverse rows and, after compacting with a 3- to 5-ton roller and checking the surface with a 10-ft. straight-edge, careful culling removes all defective

TABLE I — WEIGHT AND PER CENT PROPORTIONS OF ASPHALT-MIXES USED IN MINNEAPOLIS PAVING

	Surface Course		Binder Course		Topeka Mix		Street Mix		Cushion	
	Lb.	P. C.	Lb.	P. C.	Lb.	P. C.	Lb.	P. C.	Lb.	P. C.
Asphalt cement	240	6.00	200	5.00	320	8.00	140	3.50	125	3.13
Mineral filler	200	5.00	...	....	300	7.50	*40	1.00	*75	1.87
Asphalt sand	1,320	33.00	1,100	27.50	2,100	52.50	2,620	65.50	3,800	95.00
¼ in. No. 10 rock	240	6.00	300	5.00	400	10.00	400	10.00	....	....
¼-½ in. rock	900	22.50	900	22.50	880	22.00	800	20.00	....	....
½-1 in. rock	1,100	27.50	1,600	40.00	.....	....	....	....	....	....
	4,000	100.00	4,000	100.00	4,000	100.00	4,000	100.00	4,000	100.00

TABLE II — COMPARISON OF COMPOSITE BIN GRADINGS FOR SIX YEARS

	1921	1922	1923	1924	1925	Average 1921 1925	Typical 1936
Per Cent Asphalt Cement	**5.4**	**5.5**	**6.1**	**6.4**	**6.3**	**5.9**	**6.0**
Pass 200	5.1	5.3	6.1	5.2	5.2	5.4	5.8
Pass 80 Ret. 200	8.0	8.2	8.7	11.0	8.7	8.9	9.0
Pass 40 Ret. 80	10.8	9.7	9.4	10.9	14.1	11.0	11.8
Pass 10 Ret. 40	12.1	9.7	10.6	10.6	7.7	10.1	9.2
Total Fine Aggregate	**36.0**	**32.9**	**34.8**	**37.7**	**35.7**	**35.4**	**35.8**
Pass ¼ Ret. 10	10.8	12.4	8.8	9.2	4.5	9.1	11.8
Pass ½ Ret. ¼	17.4	17.6	17.1	21.6	19.2	18.6	18.1
Pass ¾ Ret. ½	14.9	17.3	16.5	9.4	11.9	14.0	17.7
Pass 1 Ret. ¾	11.5	11.8	12.8	13.2	15.1	12.9	7.6
Pass 1¼ Ret. 1	3.4	2.3	3.9	2.5	7.3	3.9	3.0
Pass 1½ Ret. 1¼	.6	.2	.0	.0	.0	.2	.0
Total Coarse Aggregate	**58.6**	**61.6**	**59.1**	**55.9**	**58.0**	**58.7**	**58.2**

TABLE III — BATCHWEIGHTS FOR PORTLAND CEMENT CONCRETE MIXTURES

Concrete paving	
Portland cement	576 lb.
Dry fine aggregate	1,472 "
Dry coarse aggregate	2,276 "
Concrete Base	
Portland cement	386 lb.
Dry fine aggregate	1,549 "
Dry coarse aggregate	1,893 "
Concrete Curb and Gutter	
Portland cement	288 lb.
Dry fine aggregate	720 "
Dry coarse aggregate	1,115 "

TABLE IV — COMPARATIVE MAINTENANCE COSTS OF ASPHALTIC CONCRETE

Street	Year laid	Maintenance per Sq. Yd. to 1936	Maintenance average per Sq. Yd. per Yr.
1	1898	$0.52999	$0.01394
2	1915	.03356	.00160
3	1920	.06760	.00422
4	1921	.0833	.00555
5	1921	.0410	.00273
6	1921	.0217	.00144
7	1921	.0196	.00130
8	1923	.0268	.00207
9	1923	.05031	.00387
10	1923	.0386	.00296
11	1924	.0356	.00297
12	1925	.0112	.00093
29	1924	.0162	.00135
14	1924	.0739	.00615
15	1925	.0413	.00375
16	1926	.0036	.0036
17	1926	.0039	.00039
18	1926	.0179	.00179
19	1926	.0144	.00144
20	1926	.0473	.00473
21	1929	.0105	.00150
22	1931	.0000	.0000

TABLE V — COMPARATIVE MAINTENANCE COSTS OF CONCRETE PAVEMENT

Street	Year laid	Maintenance per Sq. Yd. to 1936	Maintenance average per Sq. Yd. per Yr.
1	1912	$0.52456	$0.02185
2	1913	.0396	.00172
3	1914	.0382	.00173
4	1914	.1500	.00681
5	1914	.1306	.00594
6	1914	.0684	.00310
7	1915	.0250	.00119
8	1915	.0355	.00169
9	1913	.1220	.00530
10	1915	.0655	.00311
11	1916	.0552	.00276
12	1919	.0413	.00242
13	1921	.1986	.01324
14	1921	.0760	.00507
15	1923	.1770	.01361

TABLE VI — COMPARATIVE MAINTENANCE COSTS OF BRICK PAVEMENT

Street	Year laid	Maintenance per Sq. Yd. to 1936	Maintenance average per Sq. Yd. per Yr.
1	1898	$0.29465	$0.00775
2	1902	.27956	.00822
3	1903	.41219	.01249
4	1904	**Resurfaced**	.00241
5	1905	.08016	.00258
6	1906	.06412	.00213
7	1907	.1295	.00446
8	1912	.03467	.00144
9	1922	.1093	.00780
10	1922	.0042	.00030
11	1923	.0331	.00254
12	1923	.0201	.00160
13	1925	.1797	.01633
14	1927	.0000	.00000
15	1929	.0000	.00000

TABLE VII — COMPARATIVE MAINTENANCE COSTS OF CREOSOTE BLOCK PAVEMENT

(On streets with St. Ry. tracks)

Street	Year laid	Maintenance per Sq. Yd. to 1936	Maintenance average per Sq. Yd. per Yr.
1	1905	$0.2668	$0.00860
2	1906	1.1034	.03678
3	1908	1.3916	.04970
4	1910	.6072	.02335
5	1911	1.0487	.04194
6	1912	.2001	.00833
7	1914	1.0953	.04978
8	1914	1.6856	.07661
9	1915	1.4746	.07021
10	1915	.3275	.01559
11	1916	1.0200	.05100
12	1916	.7864	.03932
13	1916	.3480	.01740
14	1918	1.3001	.07222
15	1918	.6586	.03658
16	1918	.2183	.01212
17	1920	.7681	.04800
18	1921	.5629	.03753
19	1916	.6289	.03144

(On streets without St. Ry. tracks)

1	1914	$0.5317	$0.02416*
2	1915	.3986	.01898*
3	1917	.2748	.01446*
4	1917	.8086	.04255†
5	1919	.4281	.02518*
6	1920	.3438	.02149†
7	1920	.3259	.02037*

* Relaid in 1936. †Fair condition.

TABLE VIII — TOTAL SQUARE YARDS OF DIFFERENT TYPES OF PAVEMENT UNDER MAINTENANCE AT THE PRESENT TIME.

Asphaltic concrete	2,750,244 sq. yds.
Creosote blocks	1,528,914 " "
Concrete	1,031,416 " "
Brick	1,020,346 " "
Granite	737,717 " "
Macadam	302,509 " "
Sandstone	154,766 " "
Asphalt macadam	28,641 " "
Bituminous concrete (Tarvia)	10,532 " "
Total	7,565,085 " "

brick. A separating agent of calcium chloride, starch and water is then sprayed (Fig. 4) over the surface of the brick. Brick filler is heated to 400 deg. F. and poured over the brick. Care is used to see that all joints are filled. When the filler has cooled sufficiently, the surplus is removed with sidewalk scrapers and reused.

Essentially the same procedure is followed in placing gutters and headers as for regular brick paving with the exception that the brick courses are laid longitudinally. This does away with cutting and makes for greater speed in laying. Brick carriers are used for unloading brick from cars, piling on streets and carrying to the pavers to minimize the chipping and cracking.

The paving repair department operates as a separate division of the paving department with its own superintendent, accountant and repair crews. Six separate crews are kept busy repairing pavements.

The paving repair-cost accountant keeps detailed records of maintenance costs on every original construction project. These data are of great value to the paving department in planning new construction and to show comparative total costs of various types of pavement. A partial tabulation of these cost records is given in Tables IV to VII, with total cost per square yard from date of construction to 1936, and average unit cost per year for the same period. Table VIII shows the yardages by types now being maintained.

Drainage Basin Problems and Programs

A concise statement of the drainage basin report of the Water Resources Committee, outlining its principal features, limitations and recommendations

By Abel Wolman

Chairman, Water Resources Committee
National Resources Committee
Baltimore, Md.

IN A SPECIAL MESSAGE *on Feb. 3, which urged the adoption of a long-range public works program, President Roosevelt transmitted to Congress a report on comprehensive drainage basin development made by the Water Resources Committee. Mr. Wolman, chairman of this committee, sets down the essentials of this nation-wide investigation in the following article.* —EDITOR

THE Water Resources Committee of the National Resources Committee was assigned the task in the winter of 1936 to suggest in general terms how the United States of America might best organize and integrate the use and control of its waters for the best interest of its people.

Such an undertaking implied the three objectives of (a) determining what the principal water problems are; (b) outlining the patterns of development and control which would serve to solve these problems; and (c) suggesting projects, investigative and construction, which would fit into such a pattern.

Obviously, any student of water resources might have predicted that comprehensive compliance with such objectives would require many years of effort. It was desirable, however, to make a beginning in such studies, if only to disclose broad problems, policies, deficiencies and specific undertakings, which in themselves would call forth discussion and demand for continuing review and adjustment.

Summary of findings

The Water Resources Committee was of the belief that a reconnaissance of the nation's water conservation problems would be helpful to the engineer, the public and legislative groups. Its summary report, to the extent of some 500 printed pages, is now available and it is important to point out its salient features and its indications of future necessities.

These findings may briefly be summarized as follows:

1—In order to discover the bases, in each of the regions of the country, for a coordinated federal water policy, as a substitute for unrelated policies applicable respectively to navigation, reclamation, water power, flood control, etc., a relatively complete *picture of major or dominant regional water problems* was needed. This picture now appears in some relief, although many of its details need to be filled in.

2—In some areas, comprehensive programs for water development were sufficiently advanced for detailed exposition. The number of these was surprisingly small and quite spotty geographically. Some were so well developed that they could be presented in full outline, as, for example, in the case of the Red River of the North. Others, such as the Central Valley of California, had been so well planned as to provide almost as complete a program.

FIG. 1—WATER PLANNING DISTRICTS were laid out for the water resource studies, using the major river systems as a basis.

TABLE I — SUMMARY OF ESTIMATED COST OF PROJECTS BY TYPES
JANUARY 1937

(Cost in Thousands of Dollars)

District	Drainage	Erosion	Flood Control	Irrigation	Navigation	Pollution and Water Supply	Pollution	Recreation and Wildlife	Water Power	Water Supply	Multiple Use	Miscellaneous	Total
Group A-1 — Investigation Projects													
New England	.....	.....	$100	.....	$50	.....	$250	.....	$300	.....	.....	.....	$700
North Atlantic	.....	.....	.....	.....	.....	.....	75	.....	.....	$250	.....	$150	475
Middle Atlantic	$75	.....	.....	.....	.....	.....	443	.....	.....	10	.....	.....	528
Southeast	60	$80	37	.....	65	.....	190	$100	20	30	.....	.....	582
Ohio	25	.....	15	.....	.....	.....	315	50	.....	.....	$505	.....	910
T. V. A.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,000	.....	1,000
Western Gulf	125	.....	1,160	.....	.....	.....	50	.....	.....	325	100	.....	1,760
Lower Mississippi	400	.....	.....	75	.....	.....	.....	.....	.....	.....	.....	.....	475
Southwest Mississippi	.....	.....	100	315	.....	$80	185	.....	.....	25	1,460	.....	2,165
Upper Mississippi													
Red River of North	62	.....	302	.....	.....	30	60	10	125	36	175	285	1,085
Great Lakes — St. Lawrence	.....	.....	150	.....	50	10	25	.....	.....	.....	.....	.....	235
Missouri	.....	.....	.....	300	.....	.....	75	75	.....	30	250	10	740
Colorado	.....	.....	30	523	.....	.....	25	.....	.....	315	220	1,208	2,321
Great Basin	.....	.....	.....	514	.....	.....	.....	30	50	.....	.....	.....	594
California	.....	.....	.....	30	.....	.....	.....	.....	.....	.....	.....	.....	30
Pacific Northwest	30	.....	.....	1,143	.....	.....	383	183	.....	328	.....	1,059	3,126
Totals	777	80	1,894	2,900	165	120	2,076	448	495	1,349	6,710	2,712	19,726
Group A-2 — Construction Projects													
New England	556	4,342	13,329	.....	12,265	.....	65,788	850	.....	18,768	.....	.....	115,898
North Atlantic	169	1,237	38,753	.....	34,925	.....	138,320	.....	.....	326,252	.....	.....	539,656
Middle Atlantic	1,682	225	1,697	.....	3,269	4,940	19,802	9,100	.....	8,332	.....	.....	49,047
Southeast	4,241	386	1,081	.....	7,394	634	10,283	1,228	.....	6,826	188	.....	32,261
Ohio	1,888	.....	600	.....	2,000	.....	99,555	55	.....	1,194	.....	.....	105,292
T. V. A.	.....	.....	20	.....	.....	.....	1,304	.....	.....	550	68,501	.....	70,375
Western Gulf	120	44	3,290	400	8,602	659	2,942	293	.....	2,761	14,600	.....	33,711
Lower Mississippi	2,118	.....	112,624	.....	2,651	1,118	227	345	.....	202	31	.....	119,316
Southwest Mississippi	4,426	.....	9,233	763	.....	1,287	9,991	50	.....	14,674	17,733	.....	58,157
Upper Mississippi													
Red River of North	2,622	.....	10,043	165	45,391	.....	71,939	446	.....	33,147	.....	4,330	168,083
Great Lakes — St. Lawrence	.....	.....	1,011	.....	10,801	119	68,281	.....	.....	32,523	.....	.....	112,735
Missouri	253	.....	313	11,357	48,497	190	14,101	388	5,200	11,260	5,695	885	98,139
Colorado	43	.....	.....	17,003	.....	111	111	.....	6,000	1,208	53	.....	24,529
Great Basin	.....	.....	.....	3,543	.....	.....	552	459	.....	89	.....	.....	4,643
California	.....	.....	35,000	833	2,047	.....	3,451	369	.....	3,539	40,120	7,564	92,923
Pacific Northwest	5,689	.....	12,188	7,528	4,327	50	13,523	345	.....	1,462	57,421	.....	102,533
Totals	23,807	6,234	239,182	41,592	182,169	9,108	520,170	13,928	11,200	462,787	204,342	12,779	1,727,298
Group B — Construction Projects													
New England	60	548	25,958	.....	2,849	.....	67,477	.....	.....	5,067	.....	35	101,994
North Atlantic	302	.....	14,297	.....	881	.....	15,509	.....	.....	1,179	.....	40	32,208
Middle Atlantic	180	100	4,316	.....	1,645	204	10,626	.....	.....	20,233	.....	.....	37,304
Southeast	4,589	2,304	861	.....	1,411	.....	1,259	359	553	2,578	40	25	13,979
Ohio	.....	.....	85,350	.....	5,200	.....	21,395	.....	.....	4,465	.....	.....	116,410
T. V. A.	300	.....	.....	.....	.....	.....	2,011	.....	.....	1,153	25,980	.....	29,444
Western Gulf	.....	.....	8,515	1,967	300	555	163	.....	.....	1,680	.....	500	13,680
Lower Mississippi	94	.....	31,799	.....	926	445	423	438	.....	506	97	.....	34,728
Southwest Mississippi	213	.....	27,581	11,132	.....	.....	2,910	2,766	19,872	4,866	80,062	.....	149,402
Upper Mississippi													
Red River of North	796	89	6,523	129	.....	.....	28,855	3,125	16,699	5,728	.....	300	62,244
Great Lakes — St. Lawrence	30	.....	2,505	.....	271,646	375	43,350	1,170	.....	22,206	10,500	.....	351,782
Missouri	350	.....	274	8,585	240	.....	4,271	635	.....	2,080	500	700	17,635
Colorado	.....	.....	100	5,719	.....	.....	.....	.....	.....	572	335	.....	6,726
Great Basin	.....	.....	.....	.....	.....	.....	.....	16	.....	833	670	.....	1,519
California	318	.....	16,644	6,735	4,369	.....	1,464	1,500	.....	265	5,500	249	37,044
Pacific Northwest	131	.....	1,918	6,817	2,418	.....	154	480	.....	1,645	3,794	.....	17,357
Totals	7,363	3,041	226,641	41,084	291,885	1,579	199,867	10,489	37,124	75,056	127,478	1,849	1,023,456
Grand Total, Groups A-1, A-2, and B	31,947	9,355	467,717	85,576	474,219	10,807	722,113	24,865	48,819	539,192	338,530	17,340	2,770,480

TABLE II—RECOMMENDATION ON MAJOR PROJECTS

Atlantic-Gulf Ship Canal, Florida
Recommendation reserved pending results of most recent investigations by U. S. Engineers.

Casper-Alcove Irrigation and Power Project
Completion is recommended.

Clark Hill, Georgia, Power Project
Initiation of this and other hydroelectric projects in this district should await completion of recommended power market survey.

Colorado-Big Thompson Transmountain Diversion
Construction should be deferred until completion of investigation, now in progress, by the Bureau of Reclamation.

Fort Peck Dam
Completion is recommended.

Great Lakes-St. Lawrence Deep Waterway and Power Project
This project may be undertaken as soon as the necessary treaty with Canada is ratified.

Lake Erie—Ohio River Canal
A study project is recommended to extend the review now being made by the Corps of Engineers.

Lower Mississippi Flood Control
Additional flood control works on the Lower Mississippi, as provided for in the Flood Control Act of June 15, 1936, are recommended for immediate construction.

Grand Coulee Dam
Final completion of High dam, together with power plant, is recommended.

Ohio River Flood Control
An immediate district-wide investigation project is recommended to plan an integrated system of reservoirs for multiple use. Construction of U. S. Engineers' 14 reservoir plan as authorized in Flood Control Act of 1936, is deferred until appropriations are made and further investigation of reservoir sites is carried out by Corps of Engineers.

Passamaquoddy Tidal Power Project
An investigation is recommended of construction cost and power market, together with study of international aspects.

Santee-Cooper Power and Navigation Project
No recommendation is included in the report concerning the Santee-Cooper power and navigation project, since the project already had been approved by the President and is now in litigation (a partial PWA allotment of $6,000,000 has been made).

Bonneville Dam
This dam, for navigation use and power development, is recommended for completion.

Mississippi River Navigation Project
Completion of 9 ft. navigation channel from mouth of Missouri River to Minneapolis is recommended.

Central Valley (Calif.) Project
Completion of comprehensive irrigation, flood-control, water supply and hydroelectric power project covering entire Central Valley is recommended.

Some basins, such as the Potomac and the Arkansas, disclosed excellent plans for some purposes, such as pollution abatement, but not for others. In still others and in all too many, such as the Platte and the Sabine-Neches Basins, comprehensive study was largely lacking.

3—As was anticipated, a reasonable number of necessary investigation projects was disclosed, which should be set in motion during the next five to ten years. These covered studies of both national and local interest, such as regional power market surveys, topographic mapping, basic hydrologic data, soil-erosion control, forestation, silting of reservoirs, etc. They should serve as the basis for continuing water resources investigation for some years to come.

4—A group of construction projects which would fit the basin picture as suggested in the various water resources fields. If initiated over a period of six years their cost would be commensurate with that expended annually for some years in the past. The projects were classified into three groups: (A) available for immediate construction; (B) desirable, but likely to be delayed for various reasons; (C) indeterminate in character, either because insufficiently studied or because they should follow the class B projects.

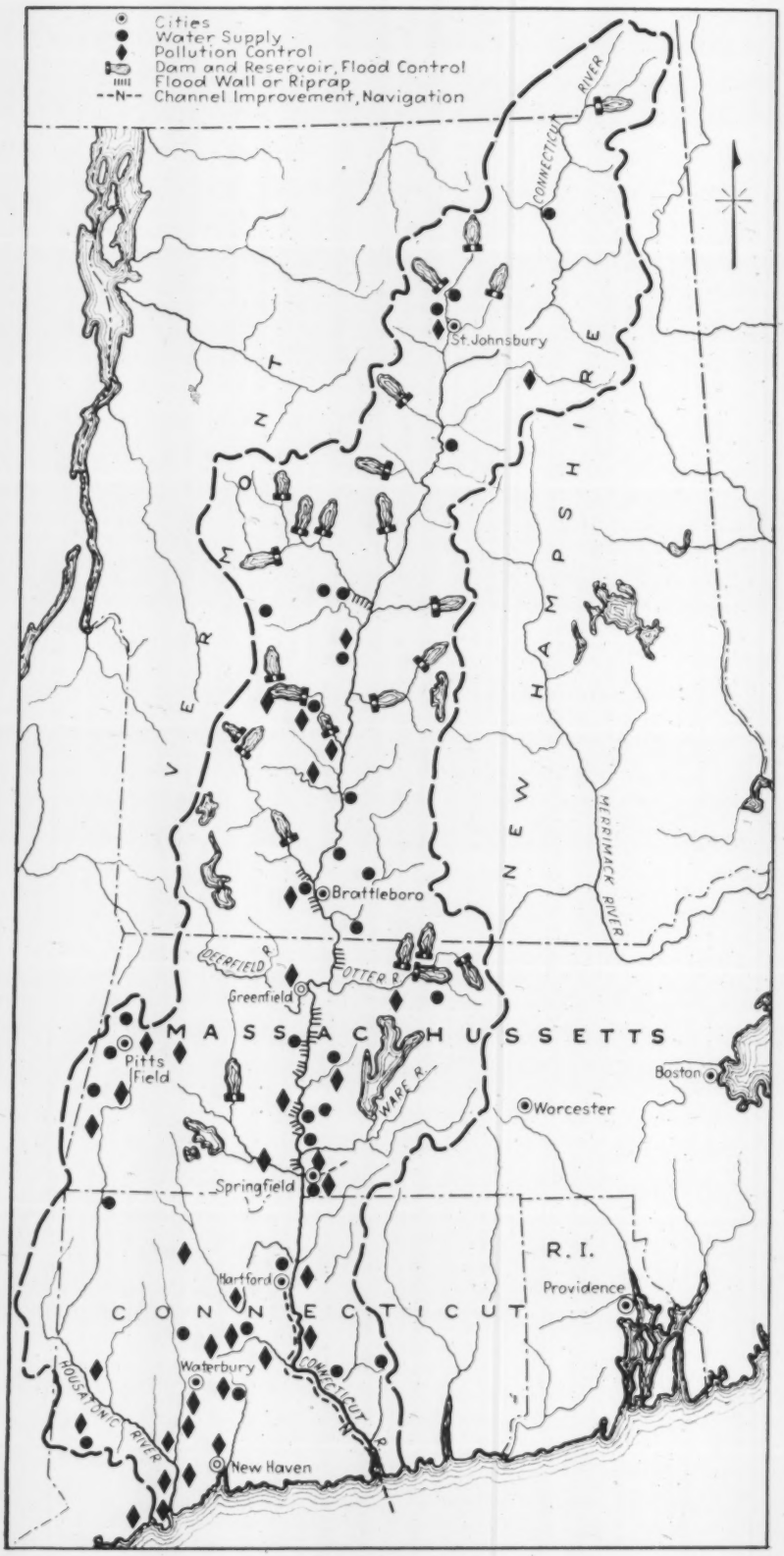


FIG. 2—THE CONNECTICUT-HOUSATONIC river systems have been studied sufficiently to permit a program of projects to be laid out tentatively.

Purpose of list

The list is intended as a reservoir for local and federal undertakings for a number of years in the future, subject, of course, to annual review, adjustment and substitution. If properly applied, the list should lead to a more orderly and planned program of public works expenditures. It cannot and should not be interpreted as a device for "rushing" public works. The rate of expenditure should be controlled by the requirements of local and central public policy.

Details as to the distribution of project costs, investigative and construction, are set forth in Table II. These costs, in Groups A and B, total approximately $3,771,000,000. It is surprising how many newspaper reviews have completely misinterpreted this figure as a suggestion for an *immediate* public-works program. It is nothing of the sort! It represents approximately $300,000,000 to $500,000,000 of available projects for annual construction on an orderly, planned drainage-basin framework, for a period of six to ten years.

From 1920 to 1929, the federal government alone spent annually in the water resources field approximately $50,000,000. In 1935, this figure reached $374,000,000. The figures proposed by the Water Resources Committee include *both* federal and non-federal undertakings.

5—No recommendations are included in the report on *apportionment of costs* as between local and central governmental units or as between various uses on multiple use projects. This omission was intentional and rested upon two considerations: (a) that regardless of origin of payment a basin pattern must rest upon needs, uses and possibilities of development; and (b) that formulas of payment are missing in a number of instances and in a stage of flux in others. The whole question of costs should be the subject of a special study.

6—Similar considerations account for the absence of recommendations regarding division of responsibility for administration. The importance of these subjects, however, cannot be over-emphasized.

The Drainage Basin Report bears no essential relation to the Public Works Planning Report, (with which it was included) except as an important illustration of the detailed type of approach to the development of a series of undertakings in a special field of public works. The recommendations in the Drainage Basin Report are so framed as to be useful in any type of public works program. They are not designed, however, for a program chiefly concerned with work relief.

Utility of survey—If Congress should follow the general recommendations of the President's committee on administrative management, the report should form the basis of a works program and of an evolving water plan. But regardless of whether Congress does or does not provide changes in administrative management, the report should be useful in (a) providing a reservoir of desirable and beneficial projects; (b) focusing attention for discussion and criticism on a tentative national program; (c) disclosing possible conflicts of interest and reconciling some; (d) establishing to an unexpected degree close working relations between federal and state agencies concerned with water use and control; (e) pointing out deficiencies in existing information; and (f) extending the horizon of water use and control from the specific project to the basin plan.

Limitations—A number of problems associated with water use and control have been given incomplete consideration, analysis and conclusion in the report. The complexity and variety of issues involved made these deficiencies unavoidable.

The collateral problems in land use, in national policies on power, flood control, reclamation, navigation, etc. and in administration and finance leave many partially unexplored fields into which it is hoped the future may permit real excursions.

Next steps

The study is preliminary. It has serious limitations in fact and in perspective, of which the Water Resources Committee is aware. "The limitations of the plan are inexorable."

To extend the investigation is the committee's next endeavor. Such an extension must come through the joint efforts of state and federal agencies with the wholehearted cooperation of the engineering profession.

Work of this extension character has already been started in the Pacific Northwest Region, the Ohio Basin, the Delaware Basin, the Colorado Basin, the New England Region and in a number of smaller areas, through the assignment of water technicians and consultants to state and regional planning agencies. These activities combined with others already in operation should push forward the study and understanding of drainage basin programs and policies in the United States.

Santa Clara Valley Subsidence Has Now Reached 5 Ft.

Known to have begun more than 16 years ago, settlement of 200-sq.mi. area near southern end of San Francisco Bay is continuing . . . Maximum settlement near southern end of area.

By E. E. Stohsnet
Aid, U. S. Coast & Geodetic Survey

REPEATED rerunning of first-order level lines at intervals of several years in the Santa Clara Valley near the city of San Jose, Calif., has shown continuous settlement of benchmarks. The area affected includes about 200 sq.mi. and the amount of settlement reaches a maximum of slightly more than 5 ft. in the business district of San Jose (population 80,000). Strangely enough, the point of maximum subsidence is not near the center of the subsiding area but is near the southern end.

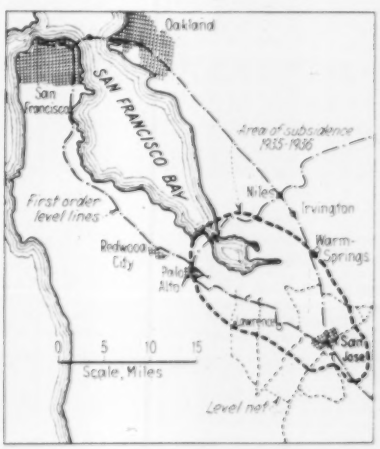
The first indication of subsidence was discovered by a survey made in 1920, checking in on benchmarks set in 1912. However, the settlement in this 8-year period was not great and importance of the matter was not fully appreciated at that time. The region was not again traversed by first-order level parties until 1932. At that time the maximum settlement had reached 4 ft., and it was apparent that considerable subsidence over a large area was involved (*ENR*, June 29, 1933, p. 845).

Plans then were made for observing subsequent changes, as described in the following. The elevations as given in this article are subject to small corrections or adjustments to be made for temperature and other factors that must be applied before the figures can be considered final. The sum of these corrections, however, probably will not change the values more than a tenth of a foot.

The earliest records of first-order leveling in this region were made in 1911-12, when a first-order level party carried a line from Brigham, Utah, to San Francisco by way of San Jose. Levels established at that time constitute the datum from which are measured the later subsidences shown on Fig. 1. Surveys made in 1920 extended southward from San Jose along the Southern Pacific R. R. tracks to Santa Margarita, Calif.

In 1931-32 the levels again were checked, this time running southward from San Francisco to San Jose and tying in all recoverable benchmarks on the old line, even though in some instances a different route was followed. This releveling was done under a cooperative agreement with the California Division of Highways. The results of

FIG. 1—LOCATION of the subsiding area is in the Santa Clara Valley at the southern end of San Francisco Bay.



BENCHMARK SUBSIDENCE IN SUCCESSIVE PERIODS

B.M. No.	Location	From San Jose (miles)	Direction From San Jose	1912 to 1932–3 (ft.)	1932–3 to 1934 (ft.)	1934 to 1935 (ft.)	1935 to 1936 (ft.)	Total Settlement 1912 to 1936 (ft.)
F-7	Redwood City	21	N-W.	0.00	0.00	0.00	0.00	0.00
I-7	Palo Alto	17	N-W.	0.35	0.03	0.02	0.03	0.43
M-7	Lawrence	7	N-W.	1.69	0.35	0.01	0.31	2.36
P-7	San Jose	0		4.02	0.54	0.33	0.26	5.15
T-7	Warm Springs	11	North	0.16	0.00	+0.02	0.06	0.20
V-7	Irvington	14	North	0.08	0.01	+0.01	0.00	0.08
W-7	Niles	18	North	0.00	0.00	0.00	0.00	0.00
				1920 to 1932–3				1920 to 1936
P-7	San Jose	0		3.71	0.54	0.33	0.26	4.84
J-19	S.P. R.R.	3	South	2.08	0.51	0.18	+0.06	2.71
L-19	S.P. R.R.	10	South	0.38	0.10	+0.05	0.03	0.46
P-19	Coyote	12	South	0.00	0.00	0.00	0.00	0.00

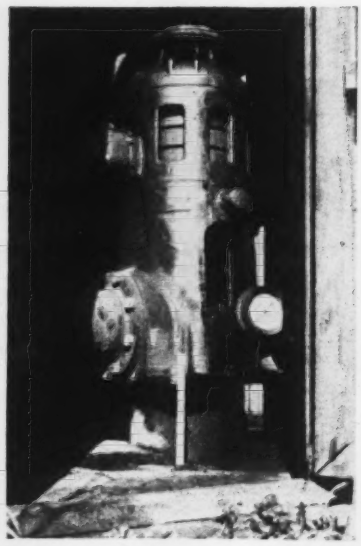


FIG. 2—PROTRUDING well casing lifted this pump off its foundation. The pump was lifted 8½ in. between 1931 and 1937. The well is 7 miles northwest of San Jose and is about 450 ft. deep.

this work established the extent of the remarkable subsidence in this area and brought about the plans, already mentioned, for closer observation.

A study of results of this survey and comparison of computations suggested additional field work to establish beyond question the extent of the surprising subsidence, particularly in the vicinity of San Jose, and also to determine the limits of the area in which settlement had occurred. Therefore during the winter of 1932-33 leveling was continued. The line from San Francisco to San Jose again was rerun, and this time it was established that discrepancy with the earliest levels appeared as far north as Redwood City, 22 miles north of San Jose. At that time (spring of 1933) the maximum subsidence on the original benchmark in San Jose was found to be about 4 ft. Starting from San Jose as a center and rerunning lines to the north and to the south established the fact that the disturbed area did not extend as far as Niles to the north nor to Coyote on the south.

With outer boundaries of the affected area thus determined it was possible to plan a network of level lines such that the rates of subsidence at various points within the area could be studied. This being done, in the spring and summer of 1934 more first-order level lines were run and old lines again were rerun. This field work provided additional information on the entire system now known as "the San Jose net," consisting of some 200 miles of first-order levels and including 360 permanent benchmarks. This entire network was rerun in the spring of 1935 and again in the spring of 1936.

Results of these successive surveys are indicated by subsidences at several

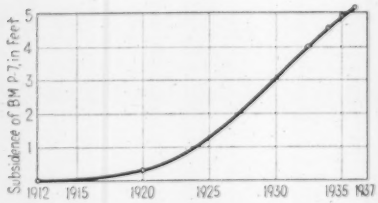


FIG. 3—SUBSIDENCE of bench mark P-7 at Hall of Records building, San Jose, Calif. (El. 93.97 ft. in 1932) indicates a fairly uniform rate of settlement in recent years.

of the more important benches listed in the accompanying table. The bench which has shown maximum subsidence is P-7, located in the north balustrade of the Hall of Records building in San Jose. Subsidence at this point is shown graphically in Fig. 3. Despite the long interval (between 1920 and 1932) during which no surveys were made, the general trend of the curve is indicated rather definitely by the observations of the past four years.

The rate of subsidence has been increasing in the vicinity of the Moffat field air base, approximately 11 miles northwest of San Jose. Benchmark P-7 at San Jose showed a settlement of 0.87 ft. during the 1932-35 period; in the same time the settlement of benchmark G-111 at Moffat field was 0.60 ft. But from the spring of 1935 to the spring of 1936, P-7 went down 0.26 ft., while G-111 went down 0.41 ft. The two benchmarks selected for this comparison represent average figures for their localities and from outward appearances are free from local disturbances.

In contrast with the settlement prevailing quite generally over a large area, a few exceptions were noted. These are slight rises or increases in elevations recorded at several points in the precise level network. Some of these are noted in the table. Whether this is merely a local condition, represents a heaving resultant from horizontal components, or has some other significance, has not been determined.

Subsidence in the vicinity of San Jose has been accompanied by a significant indication at many of the deep wells which are common in this area; some of the wells are 800 ft. deep. During the past 15 years owners have been puzzled by the apparent rising of well casings and pumps. This became measurable as the pumps lifted from their foundations. The real cause, of course, was that the foundation blocks were settling as the surface lowered, and the more stable support of the casing tended to hold the pump where it was while the foundation sank away from it. This condition proved quite troublesome; the custom has been to remove protruding portions of well casings at regular intervals in order to keep pumps on their bases. Using the length of the portions of casing cut off, it was found that some pumps had been lifted off their foundations at the rate of 2 to 3 in. per year, a total in some instances of 2 ft. This has suggested that only a small part, if any, of the subsidence can be ascribed to earth movement of deepseated origin. That is, the cause of settlement seems to reside in the first few hundred feet below the surface.

Another visual evidence of the subsidence appears on the land adjacent to the shore of San Francisco Bay and within the area where settlement is occurring. For several years here tidewater has shown a tendency to encroach upon the adjacent cultivated area. As subsidence continued it became necessary to construct dikes to protect existing improvements, including valuable fruit orchards.

Surveys have been made by the U.S. Coast & Geodetic Survey, Admiral R. S. Patton, director; Commander R. R. Lukens, inspector, in charge at San Francisco. The writer was chief of party on surveys made in 1936.

—⋄—

Many Traffic Accidents Traced to Pedestrians

JAY WALKERS and other pedestrians contribute about 65 per cent to cities' traffic tolls, according to a survey made for Columbus, Ohio, by its traffic engineer, who, when he saw the results, recommended an ordinance providing penalties for pedestrians ignoring traffic signals and rules.

As reported in the Police Chiefs' *News Letter*, bulletin of the International Association of Chiefs of Police, Traffic Engineer J. R. Guthrie pointed out that of the 2,465 automobile accidents in Columbus during the past year, 851, or 24.5 per cent, involved pedestrians. Of fatalities from these accidents, 64.9 per cent were pedestrians, while 53.4 per cent of all persons injured were on foot.

"A study of these figures," he said, "shows that pedestrians take advantage of the fact that the traffic code does not require the same obedience from them as it does from motorists. Observations at any intersection protected by a traffic light, particularly in the business area, will show conclusively that pedestrians ignore traffic lights. Arresting a pedestrian for crashing a red light might seem rather drastic, but the saving in lives and property should warrant such action."

The Police Chiefs' *News Letter* quotes recent statistics on pedestrian accidents for 1936, which indicate that over the country, 16,160 citizens were killed on the streets during the year, and 293,350 injured. Fifteen per cent of the fatalities came about through disregard of traffic signals at street intersections, and 28.7 per cent through crossing between intersections.

Determining Evaporation Losses From Weather Bureau Data

Restudy of evaporation formula confirms its practical value and defines a new coefficient applicable to the computation of water losses from large lakes.

By Adolph F. Meyer and A. S. Levens
Consulting Hydraulic Engineer, Minneapolis, Minn., and Assistant Professor, University of Minnesota, Respectively

INTELLIGENT PLANNING for water conservation demands consideration of evaporation losses. Such losses are particularly important when long-term storage for beneficial use is contemplated. When the primary aim of storing water is to retard runoff, then neither evaporation nor percolation constitutes a loss. On the contrary, they represent that portion of the rainfall which is truly conserved, because all moisture evaporated into the atmosphere must inevitably return as precipitation. The air is no storehouse for moisture. Normally, the atmospheric moisture capable of precipitation at any one time amounts to only one or two per cent of the annual rainfall. Evaporation is the prerequisite to precipitation.

The fund of evaporation data available to the designer is rapidly increasing. Papers by Rohwer (1934), Follansbee (1934), and Houk (1927) have conveniently summarized practically all observational data. Ordinarily, however, the designer of hydraulic works will not find data directly applicable to his particular problem. The hydrological conditions surrounding the evaporation station are never duplicated in his projects and he is forced to modify the observed values or compute evaporation from other physical data.

Scope of formula widened

After considerable experience in this field of hydrology, the senior author has derived some new coefficients for use in his evaporation formula, first published in 1915. ("Computing Runoff from Rainfall and Other Physical Data," *Transactions* Am. Soc. C. E., Vol. 79, p. 1,056.) During recent years, he has come to rely more and more on the results secured through the application of this formula. His equation was verified by the independent investigation of the late John R. Freeman. (Regulation of the Great Lakes, *Chicago Sanitary District*, 1926, p. 136), and by researches of Carl Rohwer. (Evaporation from Free Water Surfaces, Bulletin 271, U.S. Dept. Agric., 1931). Except for negligible changes in coefficients and a small barometric pressure correction included by Rohwer, his formula is the same as the Meyer formula.

The Meyer formula is,

$$E = C(V\text{-}v)\ (1 + W/10).$$

Where:

E = evaporation in inches depth per 30-day month.

V = maximum vapor pressure in inches mercury corresponding to monthly mean air temperature observed by Weather Bureau at nearby stations.

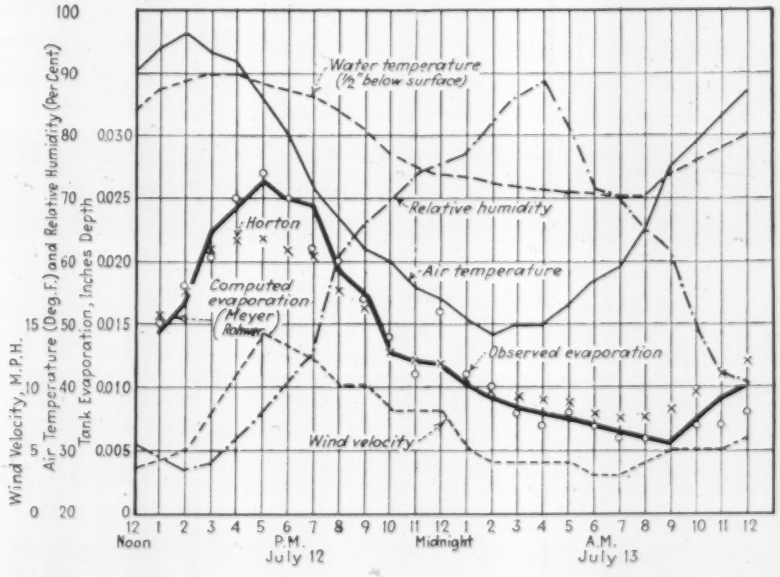
v = actual pressure of vapor in air based upon Weather Bureau determinations of monthly mean air temperature and relative humidity at nearby stations.

W = monthly mean wind velocity in miles per hour, as observed by Weather Bureau at nearby stations, about 30 ft. above general level of surrounding country or roofs of city buildings.

OBSERVED AND COMPUTED HOURLY EVAPORATION IN INCHES AT DAVIS, CALIF., JULY 12 to 13, 1910

Hour	Observed Evaporation	Computed Evaporation		
		Meyer	Rohwer	Horton
1pm	0.0150	0.0144	0.0143	0.0157
2	.0180	.0167	.0167	.0177
3	.0200	.0222	.0222	.0210
4	.0250	.0242	.0244	.0217
5	.0270	.0264	.0268	.0218
6	.0250	.0248	.0250	.0209
7	.0210	.0245	.0247	.0204
8	.0200	.0192	.0193	.0177
9	.0170	.0174	.0175	.0161
10	.0140	.0128	.0128	.0129
11	.0110	.0122	.0121	.0122
12	.0160	.0119	.0119	.0119
1am	.0110	.0101	.0101	.0108
2	.0100	.0091	.0090	.0099
3	.0080	.0084	.0083	.0093
4	.0070	.0080	.0079	.0090
5	.0080	.0076	.0075	.0087
6	.0070	.0069	.0068	.0079
7	.0060	.0065	.0064	.0076
8	.0060	.0061	.0060	.0077
9	.0080	.0057	.0057	.0082
10	.0070	.0076	.0076	.0097
11	.0070	.0092	.0091	.0110
12	.0080	.0101	.0100	.0121
Total	0.3220	0.3220	0.3221	0.3219

FIG. 1—HOURLY EVAPORATION at Davis, Calif., showing comparison of observed data and values computed by the Meyer, Horton and Rohwer formulas.



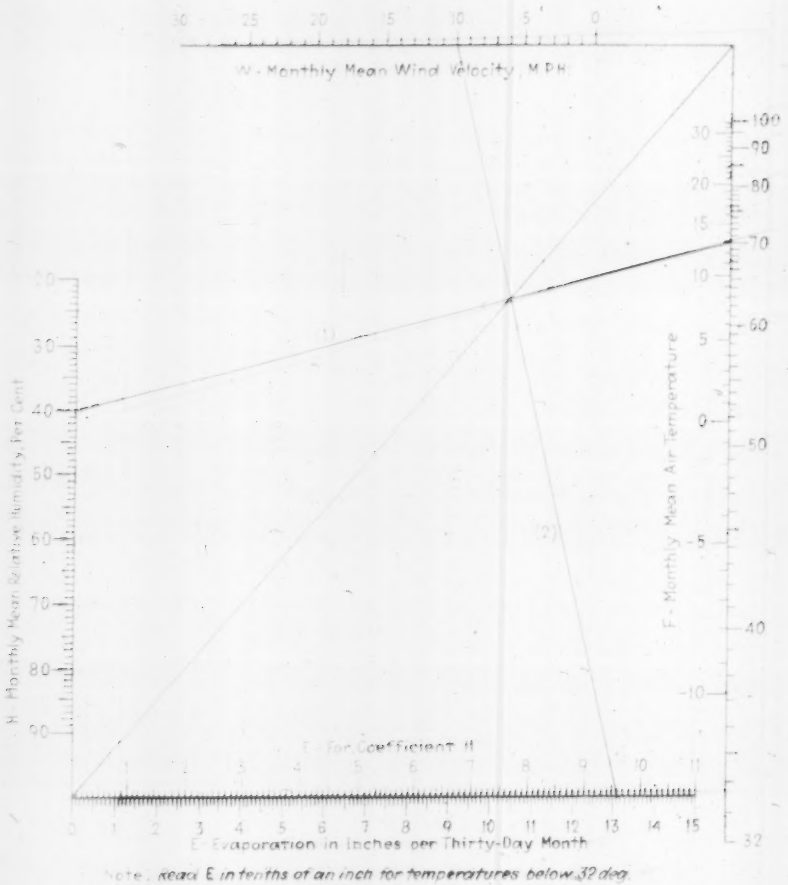

W - Monthly Mean Wind Velocity, M.P.H.
30 25 20 15 10 5 0
H - Monthly Mean Relative Humidity, Per Cent
30 40 50 60 70 80 90
F - Monthly Mean Air Temperature
100 90 80 70 60 50 40 32
E - For Coefficient 11
1 2 3 4 5 6 7 8 9 10 11
E - Evaporation in Inches per Thirty-Day Month
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Note: Read E in tenths of an inch for temperatures below 32 deg.

FIG. 2—ALIGNMENT CHART for the solution of Meyer's evaporation formula applicable for use with coefficients of both 11 and 15.

= 15 for small, shallow ponds and for moisture on grass, leaves, etc. When computing evaporation from larger or deeper bodies of water,

= maximum vapor pressure in inches mercury corresponding to water temperature instead of air temperature.

= actual pressure of vapor in air about 50 ft. above water surface.

A coefficient of 11 in this formula is applicable to lakes and reservoirs. The selection of this coefficient for evaporation from large lakes of moderate depth is based largely on the senior author's experience during recent years in computing losses from lakes in comparison with observed inflow and outflow records. Lake Traverse, on the western border of Minnesota, and Red Lake, in the northern part of the state, are typical examples.

No water temperatures were available, so an assumed water temperature of 2 deg. lower in April, 1 deg. lower in May, and 1 deg. higher in both September and October, than the air temperature observed by the Weather Bureau at the nearest stations to the windward side of these bodies of water was used in determining the maximum vapor pressure for the formula.

At least three-fourths of the inflow into Lake Traverse comes from one large tributary, for which continuous records are available. The outflow from the lake is also measured. The last heavy inflow occurred in 1921-1922. The entire outflow from 1923 to 1930 represented only 2 ft. in depth on the lake. No outflow whatever occurred between 1931 and 1934. The lake has a normal area of about 25 sq. mi. It was completely dry in November, 1934. During 1935 it recovered slightly. Evaporation computed by means of the Meyer formula, using a coefficient of 11, checks satisfactorily with the available inflow and outflow data for the period.

Red Lake has a normal area of 434 sq. mi. and the tributary drainage area is 1950 sq. mi. Computed evaporation and transpiration from the land area and computed evaporation from the water area check satisfactorily with the observed rainfall, inflow, and outflow over the period from May 1, 1929, to Sept. 30, 1934. During this period the lake fell 4.35 ft., of which the outflow represented 1.15 ft. The computed precipitation minus losses for this period, assuming no change in ground [illegible] amounts to 4.22 in. on the [illegible] equivalent to 1.22 ft. on [illegible]. Subtracting this runoff [illegible] puted excess of evaporation [illegible] cipitation on the lake (5.0 [illegible] 3.85 ft. computed loss [illegible] observed loss. This represents [illegible] of only 0.32 in. per year in the [illegible] losses from the tributary [illegible] or 1.5 in. per year error in the [illegible] evaporation loss from the [illegible] check is probably fully as [illegible] the basic data.

Check on observations

The best test of any [illegible] formula is its application to [illegible] hourly data, and the best [illegible] kind which have come to the [illegible] attention are the observations [illegible] 12 and 13, 1910, at Davis, Calif. [illegible] oration from Irrigated Soils [illegible] 248, U.S. Dept. Agric., 1913). During the period of observation [illegible] temperature varied from less than 50 deg. to more than 90 deg., the relative humidity varied from less than 10 per cent to more than 80 per cent, and the wind velocity varied from 3 to 25 m.p.h.

The evaporation tank used at Davis was 22 in. in diameter, 28 in. deep, sunk in the soil, and the upper half was surrounded by a water jacket. This resulted in much lower rates of evaporation than those from exposed evaporation pans. Because the water temperature averaged over 8 deg. higher than the air temperature, and because the true mean temperature based on hourly observations differs from the mean of the maximum and minimum temperatures for the day, and because true mean relative humidity differs from the mean of morning and evening observations, the coefficient C = 11 must be changed to 9.13 ÷ (30x24) in order to make the hourly evaporation computed by the Meyer formula check the observed hourly evaporation.

Correlation with other data

In order to make the evaporation at Davis, computed according to the Rohwer formula, check the observed hourly evaporation, it is necessary not only to divide the observed wind velocity by 2.5 to reduce it to equivalent ground wind velocity used in the Rohwer formula, but to reduce the numerical coefficient one-third. The formula thus modified, the Rohwer formula becomes:

$$E = \frac{(0.295 + 0.031W)(\quad -\quad)}{24}$$

and the Meyer formula for hourly evaporation becomes:

$$E = \frac{(0.304 + 0.0304W)(\quad -\quad)}{24}$$

The Horton formula for daily evaporation is

$$E = 0.4\ (\sqrt{V} - v)$$

Where

$$v = 2 - e^{-0.269 v_0}$$

v_0 = wind velocity at ground level

Computing the hourly evaporation by means of Horton's formula after reducing the observed wind velocity (assumed to have been taken at 30 ft. above the ground level) to the equivalent ground wind used in this formula, requires the application of a coefficient of 0.269 ÷ 24 instead of 0.4 ÷ 24 as given. For wind velocities of about 8 m.p.h., the Horton formula gives about the same results as the Meyer and Rohwer formulas. For wind velocities more than 10 m.p.h. the Horton formula gives up to 20 per cent less hourly evaporation than observed at Davis; for velocities less than 6 m.p.h. it gives up to 20 per cent greater evaporation than observed.

From a theoretical viewpoint, the Horton formula is the most logical one yet devised. It does not use the straight-line variation in wind effect employed in both the Meyer and the Rohwer formulas, which obviously does not apply to excessively high winds. Nevertheless, within the ordinary range of wind velocities, the Horton formula does not appear to give as good results, at least when checked against the Davis records, as the other two formulas.

Rohwer includes an altitude factor in his formula. For a drop in barometer from 28 in. to 18 in., he shows an increase of 18.5 per cent in evaporation. However, if, from seventy observations by Rohwer nine are omitted (namely two for Imperial, Calif., El.—68 ft.; one for Ft. Calhoun, Neb., El. 1,160; two for Logan, Utah, El. 4,778; one for Lake Tahoe, El. 6,300; one for Victor, Colo., El. 10,089; and two for Pikes Peak, Colo., El. 14,109) because on those days the records differed radically from the average for the period, due either to considerable rainfall or to excessive wind velocity, then the increase in evaporation shown by Rohwer's observations for a drop in barometric pressure from 28 in. to 18 in. is only about 10 per cent.

According to Horton's conclusions, the evaporation coefficient varies with altitude even more rapidly than the variation given by Rohwer.

In the table on p. 481 is given a comparison of the hourly evaporation as observed and as computed by the three formulas referred to, after correcting the coefficients as indicated to give the same total evaporation for the day. It shows that the Meyer and Rohwer formulas give practically identical results which check the observed values very closely. The same information is shown graphically in Fig. 1.

In *ENR* Aug. 6, 1936, the junior author published an alignment chart for the graphical solution of Meyer's evaporation formula,

$$E = 15(V - v)\ (1 + H/10)$$

A new chart (Fig. 2) has been constructed to include the recent developments presented above. This chart not only solves the original formula but also the new one applicable to lakes and reservoirs, namely,

$$E = 11(V - v)\ (1 + H/10)$$

A few examples will point out the simplicity of the new chart:

Example 1. $W = 10$ m.p.h., $H = 40$ per cent, $F = 70$ deg. Connect points 40 and 70. Then locate the intersection of this line with the diagonal. Connect this point with 10 on the W scale and read 13.15 in on the E scale.

Example 2. $W = 10$ m.p.h., $H = 40$ per cent, $F = 13$ deg. Proceed as in Example 1 but read 1.315 in on the E scale.

These are examples which would apply to evaporation of water from small ponds and for moisture on grass, leaves, etc. The following example applies to large lakes of moderate depth:

Example 3. $W = 10$ m.p.h., $H = 40$ per cent, $F = 70$ deg. Proceed as in Example 1 and read 9.60 in. on the E scale. Note that this reading is on the upper side of the E scale.

Municipal Pay Checks Getting Back to Normal

Salaries for municipal employees are on the way to complete "comeback." A recent survey by the Municipal Finance Officers' Association shows that city workers in a number of places are receiving monthly pay envelopes of proportions reminiscent of pre-depression days. Springfield, Fitchburg and Lawrence, Mass. and New Rochelle, N. Y. reported full restoration of salaries during the first month of 1937. Dallas, Tex. restored 50 per cent. Baltimore and New York City have provided for complete restorations later this year. Cincinnati and Los Angeles, Spokane and LaCrosse, Wis., are among the cities that restored salary levels late in 1936.

Return began in 1934

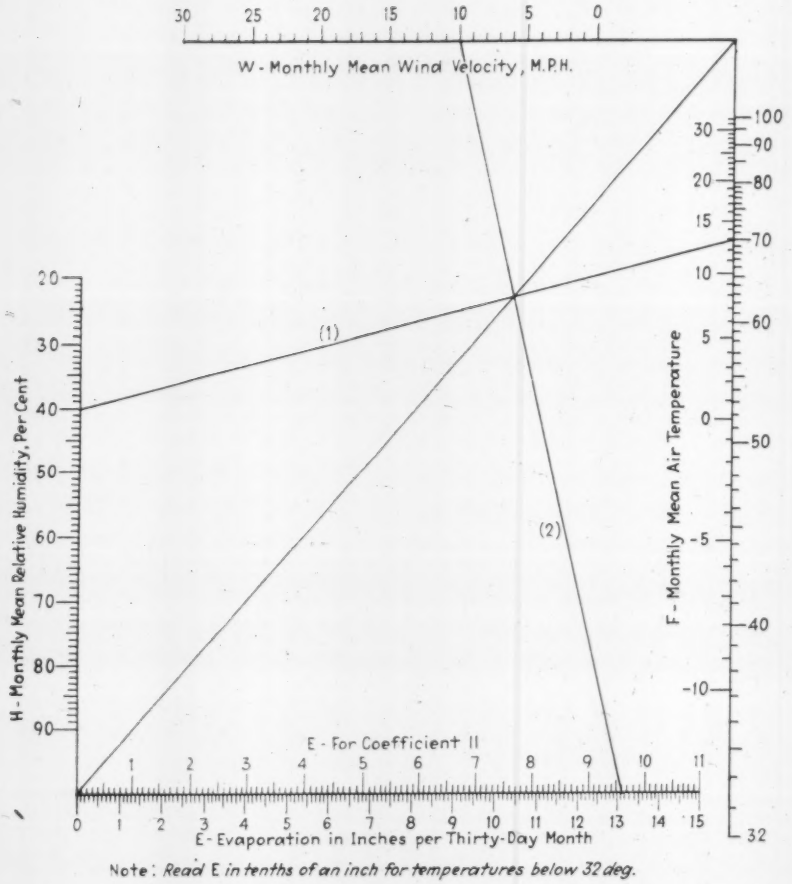
Salary replacements are not entirely a current phenomenon, Carl Chatters, executive director of the M.F.O.A., explains. There has been a gentle movement since 1934 to restore pay cuts. By the end of that year, it was stated, half of the larger American cities had reinstated salaries in whole or in part. Boston, Philadelphia, St. Louis, Denver, Fresno, Pensacola and Savannah were among the cities that made the increases before 1935. In January, 1935, Erie, Pa., restored in full a 10 per cent cut that had been in effect for two years; the city of Danville, Va., did likewise. Early in the same year 18 Michigan cities provided for general increases in salaries ranging from 5 to 20 per cent. San Francisco, Milwaukee, Newark, Nashville, Syracuse, Jacksonville, Tampa, Sacramento, Allentown, Peoria, Evansville, and others followed the move during the year.

Among cities which increased employees' pay in 1936 were Kalamazoo, Lansing and Saginaw, Mich. Ann Arbor, Mich. recently restored 5 per cent of an 11½ per cent cut. A study of twenty of the larger cities of Oregon in September, 1936 indicated that one had a salary scale higher than in 1929; four had never made any general reduction, nine had made restorations in whole or in part, and only six had failed to place salaries on the upward trend.

There were few cities which did not make some salary cuts during the years just following 1930. In April 1934, a survey made by the International City Managers' Association showed that 201 cities out of 210 reporting had reduced salaries an average of 17 per cent. Cities that made no move to economize by pay cuts during the depression included Albany and Troy, N. Y., Miami, Fla., Wilmington, Del., Council Bluffs, Ia., Newark and Springfield, O., Reading, Wilkes-Barre and York, Pa., Quincy, Mass., San Jose and Santa Monica, Calif., and also Kansas City, Kans.

In many cases restorations have been piecemeal over a period of time. Baltimore, where employees will receive full pay-checks sometime during 1937, made a partial restoration in 1934. By 1935 and 1936, the city had reduced the salary contributions exacted to 3 per cent for salaries from $1,500 to $2,100 and 6 per cent over $2,100. During the emergency period the salary reductions in Baltimore amounted to over $5,000,000.

Justification for increased salaries is found in the price indices of the United States Bureau of Foreign and Domestic Commerce, says the *Municipal Finance News Letter*. The combined index of the cost of living increased from 71.7 per cent (1923-100%) in April, 1933, to 85.7 per cent in October, 1936. This was an increase of nearly one-fourth. The index of retail food prices has risen during the same period from 59.9 to 82.9 per cent, or about 40 per cent. The news letter recalls that in April, 1935, the Congress of the United States raised all federal salaries back to normal by abolishing the last 5 per cent cut.


W - Monthly Mean Wind Velocity, M.P.H.
30 25 20 15 10 5 0
H - Monthly Mean Relative Humidity, Per Cent
20 30 40 50 60 70 80 90
F - Monthly Mean Air Temperature
100 90 80 70 60 50 40 -10
30 20 15 10 5 0 -5
(1)
(2)
E - For Coefficient 11
1 2 3 4 5 6 7 8 9 10 11
E - Evaporation in Inches per Thirty-Day Month
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
32

Note: *Read E in tenths of an inch for temperatures below 32 deg.*

FIG. 2—ALIGNMENT CHART for the solution of Meyer's evaporation formula applicable for use with coefficients of both 11 and 15.

C = 15 for small, shallow ponds and for moisture on grass, leaves, etc.

When computing evaporation from larger or deeper bodies of water,

V = maximum vapor pressure in inches mercury corresponding to water temperature instead of air temperature.

v = actual pressure of vapor in air about 30 ft. above water surface.

A coefficient of 11 in this formula is applicable to lakes and reservoirs. The selection of this coefficient for evaporation from large lakes of moderate depth is based largely on the senior author's experience during recent years in computing losses from lakes in comparison with observed inflow and outflow records. Lake Traverse, on the western border of Minnesota, and Red Lake, in the northern part of the state, are typical examples.

No water temperatures were available, so an assumed water temperature of 2 deg. lower in April, 1 deg. lower in May, and 1 deg. higher in both September and October, than the air temperature observed by the Weather Bureau at the nearest stations to the windward side of these bodies of water was used in determining the maximum vapor pressure for the formula.

At least three-fourths of the inflow into Lake Traverse comes from one large tributary, for which continuous records are available. The outflow from the lake is also measured. The last heavy inflow occurred in 1921-1922. The entire outflow from 1923 to 1930 represented only 2 ft. in depth on the lake. No outflow whatever occurred between 1931 and 1934. The lake has a normal area of about 25 sq. mi. It was completely dry in November, 1934. During 1935 it recovered slightly. Evaporation computed by means of the Meyer formula, using a coefficient of 11, checks satisfactorily with the available inflow and outflow data for the period.

Red Lake has a normal area of 434 sq. mi. and the tributary drainage area is 1950 sq. mi. Computed evaporation and transpiration from the land area and computed evaporation from the water area check satisfactorily with the observed rainfall, inflow, and outflow over the period from May 1, 1929, to Sept. 30, 1934. During this period the lake fell 4.35 ft., of which the outflow represented 1.15 ft. The computed precipitation minus losses for this period, assuming no change in ground storage, amounts to 4.22 in. on the land area, equivalent to 1.22 ft. on the lake area. Subtracting this runoff from the computed excess of evaporation over precipitation on the lake (5.07 ft.) leaves 3.85 ft. computed loss as against 3.50 ft. observed loss. This represents an error of only 0.32 in. per year in the computed losses from the tributary drainage area, or 1.5 in. per year error in the computed evaporation loss from the lake. The check is probably fully as accurate as the basic data.

Check on observations

The best test of any evaporation formula is its application to observed hourly data, and the best data of this kind which have come to the authors' attention are the observations for July 12 and 13, 1910, at Davis, Calif. (Evaporation from Irrigated Soils, Bulletin 248, U.S. Dept. Agric., 1912, p. 72). During the period of observation the air temperature varied from less than 50 deg. to more than 90 deg., the relative humidity varied from less than 30 per cent to more than 80 per cent, and the wind velocity varied from 3 to 14 m.p.h.

The evaporation tank used at Davis was 22 in. in diameter, 28 in. deep, set in the soil, and the upper half was surrounded by a water jacket. This resulted in much lower rates of evaporation than those from exposed evaporation pans. Because the water temperature averaged over 8 deg. higher than the air temperature, and because the true mean temperature based on hourly observations differs from the mean of the maximum and minimum temperature for the day, and because true mean relative humidity differs from the mean of morning and evening observations, the coefficient C = 11 must be reduced to 9.13 ÷ (30x24) in order to make the hourly evaporation computed by the Meyer formula check the observed hourly evaporation.

Correlation with other data

In order to make the evaporation at Davis, computed according to the Rohwer formula, check the observed hourly evaporation, it is necessary not only to divide the observed wind velocity by 2.5 to reduce it to equivalent ground wind velocity used in the Rohwer formula, but to reduce the numerical coefficient one-third. When thus modified, the Rohwer formula becomes:

$$E = \frac{(0.295 + 0.031W)\ (V - v)}{24}$$

and the Meyer formula for hourly evaporation becomes:

$$E = \frac{(0.304 + 0.0304W)\ (V - v)}{24}$$

The Horton formula for daily evaporation is:

$$E = 0.4\ (\psi V - v)$$

Where:

$$\psi = 2 - e^{-2.0w_o}$$

w_o = wind velocity at ground level

Computing the hourly evaporation by means of Horton's formula after reducing the observed wind velocity (assumed to have been taken at 30 ft. above the ground level) to the equivalent ground wind used in this formula, requires the application of a coefficient of 0.269 ÷ 24 instead of 0.4 ÷ 24 as given. For wind velocities of about 8 m.p.h., the Horton formula gives about the same results as the Meyer and Rohwer formulas. For wind velocities more than 10 m.p.h. the Horton formula gives up to 20 per cent less hourly exaporation than observed at Davis; for velocities less than 6 m.p.h. it gives up to 20 per cent greater evaporation than observed.

From a theoretical viewpoint, the Horton formula is the most logical one yet devised. It does not use the straight-line variation in wind effect employed in both the Meyer and the Rohwer formulas, which obviously does not apply to excessively high winds. Nevertheless, within the ordinary range of wind velocities, the Horton formula does not appear to give as good results, at least when checked against the Davis records, as the other two formulas.

Rohwer includes an altitude factor in his formula. For a drop in barometer from 28 in. to 18 in., he shows an increase of 18.5 per cent in evaporation. However, if, from seventy observations by Rohwer nine are omitted (namely two for Imperial, Calif. El.—68 ft.; one for Ft. Calhoun, Neb., El. 1,160; two for Logan, Utah, El. 4,778; one for Lake Tahoe, El. 6,300; one for Victor, Colo., El. 10,089; and two for Pikes Peak, Colo., El. 14,109) because on those days the records differed radically from the average for the period, due either to considerable rainfall or to excessive wind velocity, then the increase in evaporation shown by Rohwer's observations for a drop in barometric pressure from 28 in. to 18 in. is only about 10 per cent.

According to Horton's conclusions, the evaporation coefficient varies with altitude even more rapidly than the variation given by Rohwer.

In the table on p. 481 is given a comparison of the hourly evaporation as observed and as computed by the three formulas referred to, after correcting the coefficients as indicated to give the same total evaporation for the day. It shows that the Meyer and Rohwer formulas give practically identical results which check the observed values very closely. The same information is shown graphically in Fig. 1.

In *ENR* Aug. 6, 1936, the junior author published an alignment chart for the graphical solution of Meyer's evaporation formula,

$$E = 15(V - v)\ (1 + W/10)$$

A new chart (Fig. 2) has been constructed to include the recent developments presented above. This chart not only solves the original formula but also the new one applicable to lakes and reservoirs, namely

$$E = 11(V - v)\ (1 + W/10).$$

A few examples will point out the simplicity of the new chart:

Example 1. $W = 10$ m.p.h., $H = 40$ per cent, $F = 70$ deg. Connect points 40 and 70. Then locate the intersection of this line with the diagonal. Connect this point with 10 on the W scale and read 13.15 in on the E scale.

Example 2. $W = 10$ m.p.h., $H = 40$ per cent, $F = 13$ deg. Proceed as in Example 1 but read 1.315 in. on the E scale.

These are examples which would apply to evaporation of water from small ponds and for moisture on grass, leaves, etc. The following example applies to large lakes of moderate depth:

Example 3. $W = 10$ m.p.h., $H = 40$ per cent, $F = 70$ deg. Proceed as in Example 1 and read 9.60 in. on the E scale. Note that this reading is on the upper side of the E scale.

Municipal Pay Checks Getting Back to Normal

Salaries for municipal employees are on the way to complete "comeback." A recent survey by the Municipal Finance Officers' Association shows that city workers in a number of places are receiving monthly pay envelopes of proportions reminiscent of pre-depression days. Springfield, Fitchburg and Lawrence, Mass. and New Rochelle, N. Y. reported full restoration of salaries during the first month of 1937. Dallas, Tex. restored 50 per cent. Baltimore and New York City have provided for complete restorations later this year. Cincinnati and Los Angeles, Spokane and LaCrosse, Wis., are among the cities that restored salary levels late in 1936.

Return began in 1934

Salary replacements are not entirely a current phenomenon, Carl Chatters, executive director of the M.F.O.A., explains. There has been a gentle movement since 1934 to restore pay cuts. By the end of that year, it was stated, half of the larger American cities had reinstated salaries in whole or in part. Boston, Philadelphia, St. Louis, Denver, Fresno, Pensacola and Savannah were among the cities that made the increases before 1935. In January, 1935, Erie, Pa., restored in full a 10 per cent cut that had been in effect for two years; the city of Danville, Va., did likewise. Early in the same year 18 Michigan cities provided for general increases in salaries ranging from 5 to 20 per cent. San Francisco, Milwaukee, Newark, Nashville, Syracuse, Jacksonville, Tampa, Sacramento, Allentown, Peoria, Evansville, and others followed the move during the year.

Among cities which increased employees' pay in 1936 were Kalamazoo, Lansing and Saginaw, Mich. Ann Arbor, Mich. recently restored 5 per cent of an 11½ per cent cut. A study of twenty of the larger cities of Oregon in September, 1936 indicated that one had a salary scale higher than in 1929; four had never made any general reduction, nine had made restorations in whole or in part, and only six had failed to place salaries on the upward trend.

There were few cities which did not make some salary cuts during the years just following 1930. In April 1934, a survey made by the International City Managers' Association showed that 201 cities out of 210 reporting had reduced salaries an average of 17 per cent. Cities that made no move to economize by pay cuts during the depression included Albany and Troy, N. Y., Miami, Fla., Wilmington, Del., Council Bluffs, Ia., Newark and Springfield, O., Reading, Wilkes-Barre and York, Pa., Quincy, Mass., San Jose and Santa Monica, Calif., and also Kansas City, Kans.

In many cases restorations have been piecemeal over a period of time. Baltimore, where employees will receive full pay-checks sometime during 1937, made a partial restoration in 1934. By 1935 and 1936, the city had reduced the salary contributions exacted to 3 per cent for salaries from $1,500 to $2,100 and 6 per cent over $2,100. During the emergency period the salary reductions in Baltimore amounted to over $5,000,000.

Justification for increased salaries is found in the price indices of the United States Bureau of Foreign and Domestic Commerce, says the *Municipal Finance News Letter*. The combined index of the cost of living increased from 71.7 per cent (1923-100%) in April, 1933, to 85.7 per cent in October, 1936. This was an increase of nearly one-fourth. The index of retail food prices has risen during the same period from 59.9 to 82.9 per cent, or about 40 per cent. The news letter recalls that in April, 1935, the Congress of the United States raised all federal salaries back to normal by abolishing the last 5 per cent cut.

Experience with Light Aggregate In Concrete Construction

Material of five classifications added to cement on Fullerton school building—Capacity for absorbing moisture a factor in ultimate weight—Kiln operation important

By Ralph S. McLean
Civil Engineer, Brea, Calif.

LIGHT-WEIGHT AGGREGATE was used exclusively, except for foundation piles, in the two-story Commerce Building recently consrtucted on the new campus of the Junior College in Fullerton, Calif. During the job there was constant observation and frequent tests of the 1,600 cu.yd. of concrete, which weighed only 115 lb. per cu.ft. by reason of the light-weight aggregate used. The author made notes on conditions and methods which he believes will be useful on other jobs; the following summary of results is presented to record essential findings in the matter of absorption, methods of testing and placing the light materials, together with the author's conclusions.

Light-weight aggregate was chosen because foundation conditions are poor and it was desired to lighten the dead load as much as possible. The light aggregate, supplied by a manufacturer whose plant was about 40 mi. from the job, was made from a low-grade diatomaceous earth containing a small amount of clay. This aggregate was used for the entire structure except in the cast-in-place concrete piles. The process was to first crush the raw material, spray it with oil and then burn it in a kiln at a temperature just below that at which clinker would be formed, i.e., at about 2,100 deg. F. The oil spray had two functions: some of the oil was absorbed and helped to expand the material as it burned; some of it remained on the surface where it helped to harden the surface and assisted in the burning. The burning removed organic material at the same time that it expanded and hardened the aggregate. After burning, the product was screened into three grades: sand (everything passing a No. 4 screen); pea gravel (from No. 8 to ⅜-in. screens); and coarse aggregate (the reject from the ⅜-in. screen).

The product has a reddish brown color and for the most part the surfaces are rounded much like natural gravel. As delivered to the job the loose aggregate weighed about 40 lb. per cu.ft. and was porous enough to absorb 30 per cent of its own weight in water. The greater part of this absorption occurred quickly, as shown by the curve in Fig. 1.

It was found desirable to have the aggregate thoroughly saturated as it entered the concrete mixer. This was accomplished by spraying material in the storage bins until water trickled through at the bottom. On delivery at the job the aggregate was dumped in open piles, which were sprinkled the day before the aggregate was to be used. This program allowed excess water to drain off, leaving the material with a dry surface.

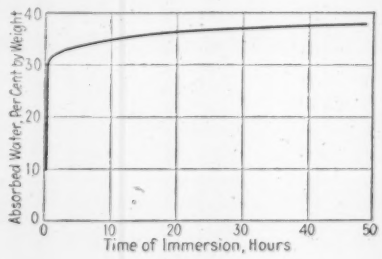


FIG. 1—ABSORPTION RATE of coarse light-weight aggregate is very rapid up to the 30 per cent point.

Although the mix was designed on a volume basis, for convenience in proportioning the measurement of mixer charges was by weight. Variations in unit weight and specific gravity therefore were important because they affected the final weight and the yield of the concrete. To check these properties samples were dried over night in an oven and the loss in weight taken to represent the water absorbed. The sample then was saturated by placing it in a wire screen cage suspended in water from a sensitive balance. The weight as indicated on this scale was recorded at intervals. After remaining immersed over night the sample was removed and the surface of the aggregate was dried off. The volume of the sample then was found by displacement in water and the specific gravity determined. For the sample whose absorption rate is shown in Fig. 1, the total absorption was 37 per cent, the specific gravity of the dry material 1.28, and that of the saturated material 1.67. These figures varied somewhat with the source of the raw material and the conditions under which it was burned.

Grading of the aggregate was by methods commonly used for natural gravel. Sieve analyses are plotted in Fig. 2. On recommendation of the testing laboratory employed to supervise proportioning, seven sacks of cement per cubic yard of concrete was specified to gain workability. Laboratory tests indicated that in order to obtain the desired strength a considerable amount of fine material would have to be added to the artificially made ingredients. This was accomplished by making up a composite fine material in which the proportions were 20 per cent silt, 40 per cent natural sand and 40 per cent light-weight sand. A more comprehensive statement of ingredients used in the mix finally developed on the basis of tests made as the work progressed is that the contents were in volumetric proportions as follows: cement, 1; silt, 0.39; natural sand, 0.78; light-weight sand, 0.78; light-weight pea gravel, 0.56; light-weight coarse aggregate, 1.69.

The weight of concrete as it left the mixer was specified to be not more than 115 lb. per cu. ft. At first this weight was checked only by weighing the test cylinders. However, cylinders made from the first six or seven pours ranged from 109 to 115 lb. per cu.ft. Thereafter the source of the raw material was changed and the burning process was revised. Tests then showed weights as high as 119 lb. per cu.ft. Investigation showed that the cause was material not thoroughly burned. This lot of aggregate was rejected and thereafter more rigid inspection was maintained both by the manufacturer and by the district authorities with satisfactory results.

To determine whether the aggregate was properly burned, samples were selected and individual pieces were broken with a hammer. If the inside did not feel hard and gritty under a knife blade, the material was considered improperly burned. Material properly burned at 2,100 deg. F., just below fusion, showed only a small percentage of soft pieces. During the latter part of the work the aggregate was weighed occasionally during the pour and the scales measuring batches into the mixer were adjusted correspondingly to maintain proper volumetric proportions. Thus the weight was kept within the specified limit and a seven-sack mix was maintained.

A very beneficial effect on the curing of the concrete is expected from the considerable quantity of absorbed water in the light aggregate. For the same reason it is believed that with age the weight of the concrete will decrease to perhaps 110 or even 108 lb. per cu.ft. A small specimen (3x4x12 in.) in a period of 4 months decreased in weight from 110 lb. to 106.2 lb. per cu.ft.

The objective was to maintain a slump of about 5 in. and to this end 6½ gal. of water was used per sack of cement. Tests were made as the concrete was delivered and the water was

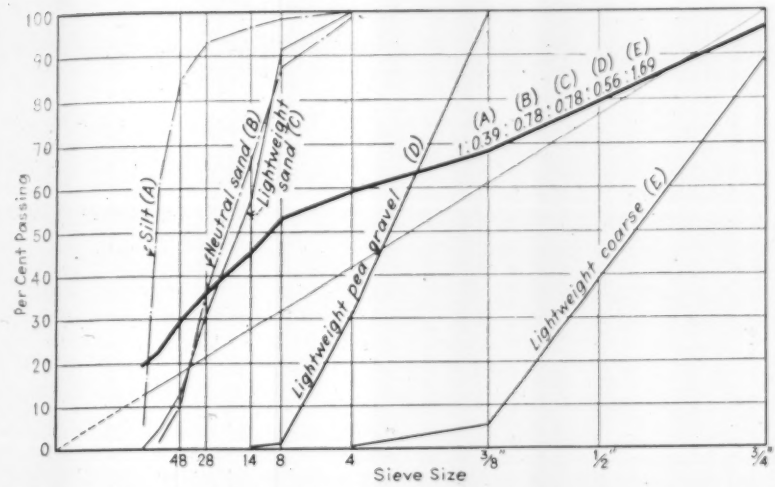


FIG. 2—SCREEN ANALYSIS plotted to show proportions in the several sizes of aggregate used.

varied when the slump departed from 5 in.

The compression tests are plotted in Fig. 3. A small amount of natural-aggregate concrete was used in the piling; compression tests for this mix are shown for comparison. The natural aggregate contained about 5½ sacks of cement per cu.yd., the proportions were 1:2:4, concrete was made in the same mixer and in all respects was handled in the same way as was the light-weight aggregate.

Workability of the light-weight concrete was all that could be desired. Exterior walls of the building had been designed for continuity with 35-ft. joist spans. Vertical steel was provided in each face of the 10-in. walls, and much of it was ¾-in. bars spaced 4 in. apart. In addition there were vertical ½-in. bars, 24 in. on center; ½-in. horizontal bars in each face and ⅝-in. diagonal bars in two directions. In spite of this quantity of reinforcing, when forms were stripped almost no rock pockets were found. The exterior walls, which were cast against rough lumber and were finished with a brush coat after stripping, present a very pleasing appearance.

The concrete was placed in the walls through tremies and an internal vibrator was used. The vibrator caused the concrete to flow freely but there was no segregation of the aggregate. Joists and slabs also were vibrated.

Since both natural and light-weight aggregates were used on the same job, it is possible to compare costs. For the natural-aggregate concrete the materials, including 5.55 sacks of cement per cu.yd., cost $5.89; for the light-weight concrete, containing 7 sacks of cement per cu.yd. the corresponding cost was $9. One extra man at the mixer was required with the light-weight aggregate because one more ingredient (sand) was used. It was assumed that silt would be used with a natural-aggregate concrete. The contractor stated that in his opinion the difference in the weight of the two types of concrete did not warrant figuring any reduction of cost in form material and shoring for light aggregate. Apparently, there was no saving in labor on wheeling the material to the forms, although its ease of placing may have somewhat decreased the labor cost in that operation. Except that the modulus of elasticity for the light-weight aggregate was set at 1,500,000, the design factors were assumed the same as those for natural-aggregate concrete.

Light-weight concrete of this type has excellent workability, and a properly designed mix will flow without segregation into very congested members, particularly when vibrated. Careful inspection of the material during burning is very important, and occasional tests should be made in the field to insure that the desired unit weight, yield, and strength are obtained. Strengths of 2,000 lb. per sq.in. or possibly 3,000 lb. per sq.in. can be obtained consistently, but require the use of a greater amount of cement than is necessary for natural-aggregate concrete. Where the saving in weight is of sufficient importance to justify the expense of the extra cement and of the light-weight aggregate, and where design strengths of 2,000 lb. per sq.in. are used, light-weight concrete may well be utilized.

Plans for the building were prepared in the office of the school plant superintendent, E. A. Ames, by the resident architect, Harry K. Vaughn. H. C. Clar was the structural designer and the writer was engineer for the school during construction. The contract was held by John Strona & Son, of Pomona, Calif.

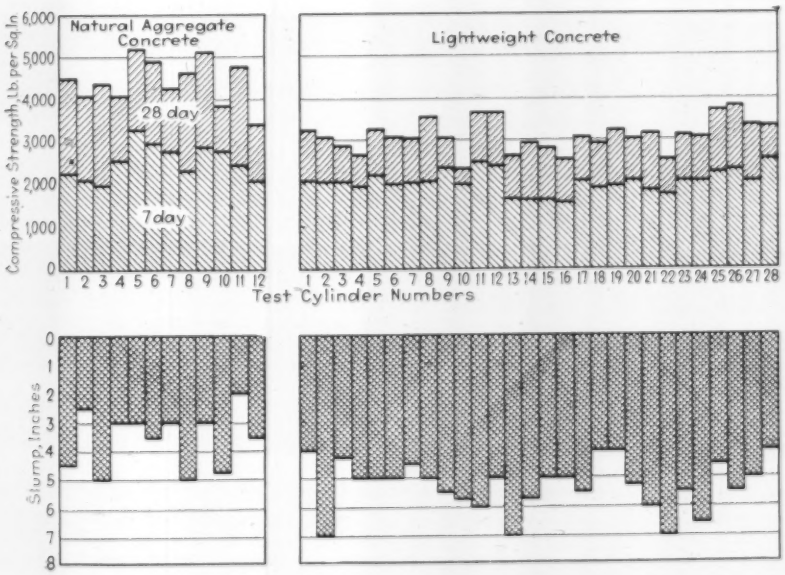


FIG. 3—STRENGTH AND SLUMP tests recording comparative value for natural and light-weight aggregates.

Engineer Shortage in Scotland

A shortage of younger engineers in Scotland is causing intense competition among municipalities and private firms for their services. The situation is particularly marked in the case of engineers for sewage and drainage works, of which a large number are being built by municipalities because of the generous government grants being made. The Lanarkshire County Council has been forced to increase its salary ratings for engineers, since it is unable to obtain men at the salaries now provided. The average salary being offered to junior engineers throughout Scotland is $1,000, general engineers $1,500 and men of greater experience $2,250.

More Research Planned At A.R.E.A. Meeting

Expansion of research in the field of railway maintenance and construction planned for at the 38th annual meeting of the America Railway Engineering Association—Progress on current research reported—Problems connected with high-speed trains considered

THE NEED for more research into track-structure problems and means for meeting the new problems introduced by high-speed trains were among the important subjects discussed at the 38th annual meeting of the American Railway Engineering Association held in Chicago, March 16-18. Also significant was the progress made by many of the committees in outlining a program of work from which it is hoped that the work of the association's committees can be more closely coordinated and carried forward in more orderly fashion than has been possible in the past. In this connection, P. B. Motley, engineer of bridges, Canadian Pacific Ry., put up to the board of directors the question of whether the present committee set-up is not resulting in unnecessary confusion and conflict between the committees. Mr. Motley pointed out that the association now has three standing committees all concerned with bridges, *i.e.*, the committees on wood bridges and trestles, iron and steel structures, and masonry, and it also has a special committee on impact, a subject that is of concern to all three committees. He expressed the belief that it would be better to have one committee on bridges with subcommittees on the several types of structures.

Research

At the opening session (*ENR*, March 25, p. 460), A. R. Wilson, president, took research as the subject of his address, emphasizing the need for much more research in the field of railway maintenance and construction. Mr. Wilson was followed by J. M. Symes, vice-president, Association of American Railroads, who stated that the A.A.R. is making plans for expansion of its research program, a program that will include continuation and expansion of the research of the A.R.E.A. Subsequently, Prof. H. F. Moore of the University of Illinois under whose direction the joint rail studies of the A.A.R. and the rail manufacturers have been conducted during the past few years, reported that the contract with the University of Illinois has been extended two years and that $50,000 would be expended each year, half to be contributed by the A.A.R. and half by the steel companies. New studies to be conducted include both field and laboratory research on the continuous welding of rails and field tests on joint bars.

Reporting on the rail research work of the past year, Professor Moore stated that field tests were conducted on 110 lb. rails on a section of well maintained single track on the Santa Fe and on a ballasted deck bridge. The tests show that hard spots in track contribute to the development of high wheel loads, (which are recognized as contributing factors in the development of transverse fissures) but that nothing yet can be deduced as to the relationship between the stiff tracks on bridges and the development of fissures.

On the matter of acceptance tests for rail, which has been the subject of continued laboratory studies, Professor Moore stated that efforts to develop a non-destructive test have been encouraging although the acoustic-electric test device reported on last year has given disappointing results. Of the destructive tests, the committee favors the bend test over the drop test now in general use, as it gives all values that can be obtained from the latter plus strength values. The studies have shown that the speed of application of the load is not significant, as had been assumed by those who favor the drop test.

The research committee has been studying the five principal methods now used in end hardening of rails and has found that not only is the strength improved but also toughness and ductility. This, Professor Moore pointed out, indicates the possibilities for improving both the strength and ductility of the entire rails by properly controlled heat treatment. The study of controlled cooled rails is to be begun at once at the Birmingham plant of the Tennessee Coal & Iron & Railroad Co., a subsidiary of the U. S. Steel Corporation.

Heating sound rail in hydrogen, Professor Moore said, had been found to produce shatter cracks (accepted as the source of transverse fissures) but the tests do not show that hydrogen is the only factor required to produce such cracks.

Prof. A. N. Talbot reported that the special committee on stresses in track has continued its studies of the long stretches of welded rail on the Delaware & Hudson R.R., begun in 1935, and that in August last it had undertaken a study of a stretch one mile long on the Bessemer & Lake Erie R.R. The purpose of these tests is to learn something of the magnitude of stress developed in the rail and to study the anchoring effect of ties and ballast. Little change in length of rail is found for varying temperatures except for about seven rail lengths at each end. In the intermediate section, temperature changes produce stresses ranging from 8,000 to 12,000 lb. per sq.in. Dr. Talbot pointed out that this stress is in addition to that resulting from wheel loads, and that very high concentration could result from poor tracks or from defective rolling stock. He stated that a break in one of the D. & H. sections of welded track had resulted in an end movement of 1½ to 2 in.

The committee on track included in its report a study of a mile-long section of welded rail on the Bessemer & Lake Erie on which 131-lb. RE rails and GEO tie plates and fastenings are used. Permanent monuments have been set up for accurate check of rail movement and provisions have been made for attaching strain gages to determine stresses in rails. The rail committee reported that it is making plans for studies of various types of welded joints (gas, Thermit, and flash welds). The tests will be carried on in laboratories with the cooperation of the manufacturers of welding equipment.

Rail joint tests

Dr. Talbot stated that plans for tests on rail joints in high-speed track are being perfected and that the electromagnetic strain gages used in the Pennsylvania tests are to be used. He stated that an instrument to measure track depression has been devised and will be put into use in these tests. The strain gage used in the Pennsylvania tests was on display at the General Electric Co.'s booth at the railway show.

The rail committee also reported on the tests on joint bars, stating that tests will be made both on 112-lb. and 131-lb. RE rails. The latter will be made on the Pennsylvania R.R. and the former on the Santa Fe. It is proposed to include mile-long test sections of track each equipped with one of seven types of joints for 112-lb. rail and twelve types for the 131-lb. rail. All the rails are to be of the controlled-cooled type and all the rail ends on one rail of the track will be end-hardened. An expenditure of $10,000 on this work has been authorized.

Use of long rails

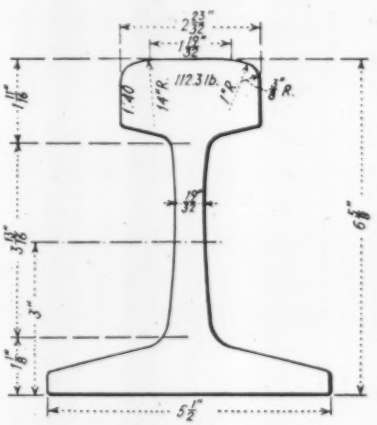
The rail committee submitted a report on the use of rail lengths in excess of 39 ft., including a survey of European practice. Both the Lehigh Valley and the C.B.&Q. have had ten miles of 66-ft. rails in service for several years. Present mill practice is to roll three 39-ft. rails at one time, hence limiting the length to a maximum of 117 ft. without requiring rebuilding of the rolling mills. No conclusions were reported on the advantages of these long rails as compared with the use of 39-ft. rails other than the statement that the Lehigh Valley found the cost of laying its 66-ft. rails to be somewhat less than the cost of laying shorter rails.

Annual rail-failure statistics prepared by the rail committee, show that for rails in five-year service, up to the end of 1935 the rails rolled in 1930 averaged 60 failures per 100 miles of track in 1935, a decrease of 61.2 from those of the 1929 rails in 1934 (121.2). Transverse fissures during 1935 totaled 12,364, as against 9,820 in 1934, but of this high total 60.6 per cent were discovered before actual breakage. During the period 1929-1935, inclusive, there was a total of 56,247 transverse fissures, of which 41.9 per cent were detected before failure. The A.A.R. detector car has tested a grand total of 40,100 miles of track, with a steady increase in the number of transverse fissures detected per mile of track tested.

New rail section

In 1933 the association adopted the 112-lb. RE rail section and the section immediately went into quite general use. Within two years several roads reported considerably more flow of metal and beading on the gage side of the head of the new section with its 24-in. top radius than was the case with the previous 110-lb. RE section with its 14-in. top radius. As a result, the rail committee began a study of the new rail and found, first, that it was difficult for the mills to control the rolling of the rail to obtain the specified 24-in. radius for the top and that in many instances the radius was from 14 to 16 in. instead of 24 and, second, when the 24-in. radius was obtained, the cold rolling of the wheels resulted in a cross-wise flow of metal and corner beading. As a result, the committee presented a new rail section to the association for its approval. The section as approved is shown in the accompanying drawing.

C. W. Baldridge of the Sante Fe took exception to the committee's explanation of why flow and beading occurred on the head of the new rail, stating that his studies show that the radius generally was around 12 in. instead of 24 and that the real explanation



NEW SECTION for 112-lb. rail.

of the flow of metal is found in the fact that the adzing machines are not properly adjusted when preparing track for the new rail with the result that the rail stands vertical instead of being canted, as required under the A.R.E.A. specifications. He stated that the sharper curve will result in greater concentration of pressure and will produce higher internal stress. In reply to Mr. Baldridge's statement, R. T. Scholes of the rail committee said that his railroad (C.B.&Q.) has used a large amount of rail with the new section and has found it a definite improvement over the old section.

The rail committee submitted for information of the association a set of specifications for the controlled cooling of rails with details of the temperatures at which rails should be placed in the cooling boxes, rate of cooling, etc. Rails subjected to controlled cooling are to be stamped "CC".

Effect of speed on tracks

An informative report on the effect of higher speeds on the labor cost of track maintenance was presented to the association by the committee on economics of railway labor. Its importance lies in its emphasis on the fact that the chief problems of track maintenance that have come with higher speeds are not due primarily to the higher speeds of the trains built especially for high speed service but are due to the speeding up of other passenger and freight services. On this point the committee said: "Steam locomotives designed especially for high-speed passenger service with well distributed loads and proper counterbalance have little damaging effect on tracks, certainly not more than standard passenger locomotives at ordinary speeds. When it comes to freight locomotives, however, the situation is different. Few locomotives in freight service today are designed for the speeds at which many of them are being operated. The result is that they knock the track out of line and, in extreme cases, bend the rail, thus adding materially to the labor requirements for maintenance. Even where passenger locomotives of the usual design are run at the higher speeds, their effect is noticeable immediately in increased labor and track maintenance. Diesel power units, which have proper load distribution and counterbalancing, and light-weight passenger cars, when operated at high speeds, are no more destructive to tracks than the usual type of passenger locomotives and cars when operated at ordinary speeds."

The committee stated that the higher speeds have brought no fundamental change in the form of track construction, and there is little indication as yet that the present design of track is inadequate for maximum speeds at which the fast trains are now being operated. The higher speeds call essentially for greater refinements in line and surface than can usually be justified for ordinary speeds. They also call for revision of curve practices and they increase the piecemeal destruction of tracks which occurs constantly at all speeds. Diesel-powered trains are only slightly more destructive to track when running at maximum speeds than when running at moderate speeds, and as compared with high-speed freight trains their effect is practically negligible.

High-speed turnouts

Evidence of the effect of higher speeds on railway design work is found in the report of the track committee which included standard plans for No. 18 and No. 20 turnouts. The No. 20 turnouts are 156 ft. long and have 39-ft. switch points.

The railway labor committee submitted the second of its reports on the analysis of railway operations that have had a marked effect in reducing labor required in maintenance of way work, the report this year having to do with the Norfolk & Western Ry. The Norfolk & Western for many years has consistently invested a liberal share of its earnings in such improve-

ments. The outstanding value of the study, the committee states, is to emphasize the fact that the Norfolk & Western policy of betterment not only made possible a reducion of man-hours employed in maintenance work prior to the beginning of the depression, but also permitted a reduction of maintenance labor during the lean years that was proportionately greater than reduction in revenues, and this was accomplished without any lowering of its standards of maintenance.

New information on the use of power equipment in track maintenance was presented by the committee on maintenance of way work equipment. Included were reports on the use of electric tie tampers and on the adaptability of crawler-type tractors to maintenance work, also a long report on machines for laying rail and their auxiliary equipment.

Specification for the manual

Specifications for cast iron culvert pipe were submitted by the roadway committee for inclusion in the manual. The committee states that the specifications now in the manual depart so much from those generally used as to make their application increase the cost of culvert pipes greatly. Last year the committee proposed that the specification in the manual be withdrawn and that the society adopt the same specifications as had been adopted tentatively by the A.S.T.M. It now proposes that A.S.T.M. specification A142-35T be included in the manual. This recommendation was approved after some discussion of whether or not the association should print A.S.T.M. specifications in its manual or whether it should include only a reference to where the A.S.T.M. specification could be found. General opinion seemed to be that the specifications should be printed in the manual with a clear indication that they are A.S.T.M. standards.

The ballast committee submitted new specifications for stone ballast and a proposed method for abrasion tests on coarse aggregate by the use of the Los Angeles testing machine (*ENR*, March 7, 1935, p. 350), a device which the committee states is gaining in popularity for determining abrasive resistance of crushed stone, slag and gravel and will probably replace the Deval test.

An interesting feature of the roadway committee report was a summary of experience with the use of concrete slabs for roadway purposes both in tunnels and on soft ground. Installations of such slabs during the past 28 years were listed with comments as to the condition of each.

Last year the committee on wood bridges and trestles submitted for discussion a design for a ballasted deck trestle for E-72 loading. No adverse criticism having been received during the year, the committee this year submitted the design for inclusion in the manual as recommended practice. At the meeting this year B. R. Leffler, bridge engineer of the New York Central, objected to the design in that four of the six piles or posts in each bent are battered. He holds that only one batter pile at each side is needed and that the use of vertical piles for the remainder of the bent results in economy in design and construction. Mr. Leffler added that there is need for a study of the mechanics of trestles. Despite his objection, the design was adopted.

Treated timber trestles

The committee also submitted for consideration an open deck pile trestle design in which special attention has been given to the use of treated timber by minimizing the amount of field cutting that is necessary in assembling the trestle.

The committee on wood bridges and trestles has compiled a bibliography on the bearing power of piles to supplement the one published in *Proceedings* of the American Society of Civil Engineers for August, 1931. Copies may be obtained from the association headquarters as soon as the bibliography has been mimeographed.

Steel structures

A statement on the application of fusion welding to steel structures was submitted to the association for its information by the committee on iron and steel structures, its purpose being to inform those considering the use of welding as to the essentials of successful use of the process. G. A. Haggander, chairman of the committee, stated that it has asked for funds to study the relation of welding to steel structures such as railway bridges in which a reversal of stresses may be high.

The committee on impact reported that it had done no field work during 1936 but that it had reviewed the work in progress on the Pennsylvania R.R. with a view to arranging a plan of field work. Instruments originally installed in 1935 on the Pennsylvania work were improved for the 1936 program, and since that time another type of instrument has been developed in work on another railroad which appears to have desirable qualities. Design and manufacture of equipment such as would be required for an adequate program of tests would require about five months and the cost of the program would be such as to require it to be financed by a special appropriation and carried out under the supervision of the director of research of the A.A.R. The committee recommended that such an appropriation be made.

Meyer Hirschthal, concrete engineer, D. L. & W., objected to the fact that the program of work as laid down by the impact committee covers only steel structures. Mr. Hirschthal called attention to the fact that the original resolution under which the special committee on impact was set up called for the study of impact not only on steel structures but on structures of concrete and of timber.

Specifications for rigid-frame concrete bridges were submitted for inclusion in the manual by the committee on masonry and were approved for that purpose. The committee also submitted for the information of the association a report on vibratory placement of concrete.

Much time was lost in discussion of a recommendation of the masonry committee that A.S.T.M. specifications for high-early-strength portland cement and for standard methods of sampling and test be printed in a supplement to the manual. Objection was immediately raised on the floor to printing supplements to the manual on the ground that the present revision of the manual to loose-leaf form was designed to eliminate the need for supplements. In the end it was decided to print the A.S.T.M. specifications in the manual. This committee also stirred up more discussion by proposing a set of general specifications for soil testing for foundations. Part of the controversy centered around the fact that the study of soil mechanics has been assigned to the roadway committee rather than the masonry committee and part resulted from statements made from the floor by B. R. Leffler to the effect that too much faith is being placed in the new science of soil mechanics at the present time, that it is largely theory unsupported by experience.

Pumped concrete

The masonry committee submitted tentative specifications for placing of concrete by pumping. Specifications for reinforced brick masonry chimneys and for cement-grouted macadam platforms, floors and pavements were submitted by the committee on buildings and approved for inclusion in the manual.

Railway location

Data on electric locomotives needed by engineers studying the location or relocation of lines using electric locomotives were given by the committee on the economics of railway location. These included a comparison of steam and electric locomotive performance. Information on the comparative economic value of steel, treated timber and concrete in bridges was submitted by the committee on economics of

bridges and trestles and the committee on economics of railway operation reported on methods for determining the effect of a moderate change in traffic density on the operating ratio of a railway.

Crossing elimination

The formal presentation of committee reports was suspended temporarily Wednesday morning in order that the convention might hear Thomas H. MacDonald, chief of the Bureau of Public Roads, speak on the relation of highway to rail transportation, particularly with reference to the elimination of grade crossings. Mr. MacDonald cited the crossing elimination provisions of the Emergency Relief Appropriation Act of 1935 as evidence of changed attitude on the part of the public toward the elimination of grade crossings. Before the passage of that act, state legislation had required that the railroads bear a large part of the cost of crossing elimination, the average being about 50 per cent, thus putting a serious handicap on the progress of that work due to the inability of many railroads to finance their share of the cost. Previously in 1933, a start had been made in financing crossing elimination through federal-aid, but it was not until the 1935 act that the work was put on a scale that promises the elimination of the worst crossings within a reasonable period. In the 3½ years since the federal-aid work started 3,146 crossings either have been eliminated or now are in the process of elimination.

Despite this rapid progress, Mr. MacDonald pointed out that it will be many years before even all the major crossings in the country will be eliminated. This calls for adequate crossing protection devices for use at all crossings that cannot be eliminated quickly and it is here, Mr. MacDonald stated, that railway and highway engineers can cooperate to advantage. Mr. MacDonald also stated that the two groups can cooperate in speeding the present survey of highway crossings that is being conducted by the Bureau of Public Roads. With this survey completed, it will be possible to undertake an intensive study which should result in the elimination of many crossings by either highway or railway relocation.

Another field in which railway and highway men can cooperate said Mr. MacDonald, is in soil stabilization studies. Highway departments in many states and the Bureau of Public Roads are now actively engaged in such studies and Mr. MacDonald believes that the result will be equally applicable to the stabilization of railway embankments. Another study being conducted by the bureau is one of bids on grade crossing work from which it is hoped to develop information of value both to the highway and railway field as to unit cost of such work.

Following Mr. MacDonald's talk, the highway committee presented its report which included details of a suspended type of crossing signs for locations where it is not practical to place the crossing sign on a post. The committee also submitted details of reflector type signs for crossings where watchmen are off duty or the gates are not working during certain hours of the night. A statement of requisites for automatic gates also was submitted.

Driving Wakefield Pile Cutoffs

SHEETPILING is used extensively at Imperial Dam to lengthen the percolation slope under embankments and to prevent water from seeping through the fine silt which underlies the large amount of tightly compacted fill required on this job. A total of more than 4,000 ft. of Wakefield piling is used in two lines of training works in connection with diversion for canal intakes on the Arizona and California sides of the Colorado River.

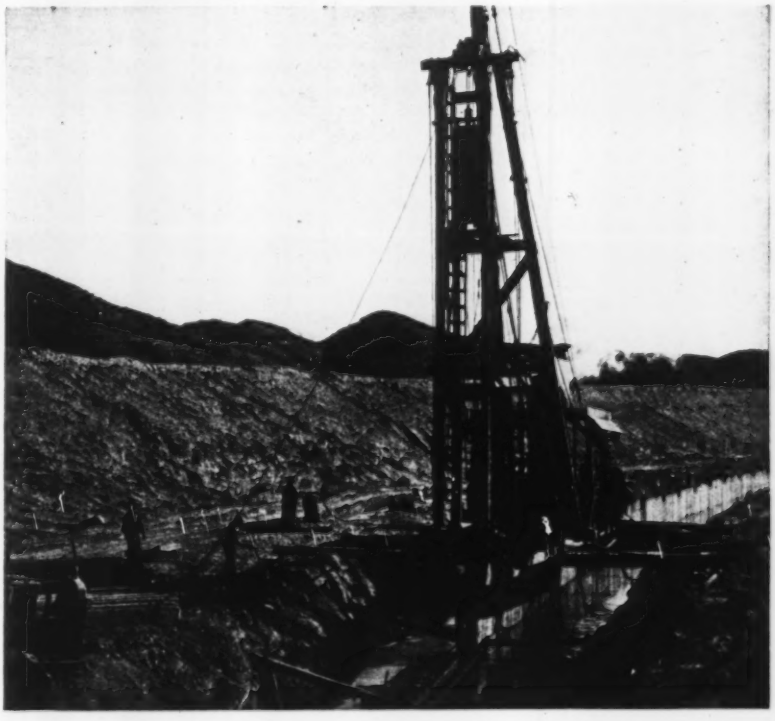
The accompanying picture shows typical construction of the Wakefield piling cutoff under the right or lower bank of the Gila Valley canal. Each tongue-and-groove pile is built up by spiking together three 3x12-in. planks 20 ft. long. These are delivered by trucks to the nearest accessible point and thence are snaked to within reach of the pile driver by a tractor. The piling is driven in a trench, along the center line of the projected fill.

To speed placement of the piles on the desired alignment a pair of guide walers is kept ahead of the driver as the work progresses. At their rear ends these walers are supported on blocks spiked to piling already in place; lateral braces to the bank also are put in. The forward ends of the walers rest on a block in the shallow water of the trench and are braced laterally to the trench sides.

Behind the driver the top of the sheetpiling is seen to have what appear to be notches at regular intervals. These result from driving an occasional pile about 1 ft. deeper than the others to accommodate caps that span the trench as supports for the driving rig. The caps are moved ahead as the rig advances.

The work is being done under contract for the U.S. Bureau of Reclamation. The Merritt-Chapman & Scott Corp. is driving all the piling for Imperial Dam under a subcontract from Morrison & Knudsen, Utah Const. Co., and Winston Bros., general contractors.

Fig. 1—PILE DRIVING RIG putting down Wakefield sheetpiling at the intake of the Gila Valley canal, Imperial Dam.



Letters to the Editor

Flood-Plain Trespassers

Sir—Your editorial of March 11th, "The River's Rights", touches a point to which I have given much thought and the more I think about it the more strongly I feel that flood protection is not to be done at the expense of the general taxpayer. Its worthwhileness is to be measured by the benefits to the area protected, and its cost should be charged against that area. If a farmer feels that river bottoms are more fertile and will produce larger crops, he deliberately takes a risk in settling there. If a railroad feels that it costs less to locate its tracks near the streambeds, it takes the risk of flood repairs.

It has given me a large measure of satisfaction to see someone touch on this point of view. Personally I had no means of expressing it, but it does give me much satisfaction to endorse your stand.

HENRY PAUL BUSCH

Philadelphia,
March 24, 1937.

Unenforceable Contracts

Sir—Just how careful engineers must be when dealing with public authorities is well illustrated in the case of Nuebling and Mast, etc., v. Topton Borough, 323 Pa. 154 (1936). In that case, the borough was considering the enlargement of its water supply. At a regular meeting of the borough council in which the entire membership was present, Neubling and Mast, civil engineers, were also present and discussed with the members present, the present water supply and answered many questions. The president of the council then asked whether they desired to engage Nuebling and Mast as engineers to prepare plans and specifications for a new water supply. All but one voted yes.

Plans and specifications were prepared and on the strength of them, a special election was held to ascertain whether a loan should be floated to pay for the new water supply system. The plans were approved and accepted by the council. The engineers then presented their bill for preparing the plans and specifications.

The claim which was admitted as being fair and reasonable, was not paid and thereupon suit was brought. The defense was raised that the contract was an oral one and did not comply with the statutes which provide a formal mode of creating municipal contracts. The lower court entered a compulsory non-suit. Upon appeal, the supreme court of Pennsylvania sustained the compulsory non-suit, holding that the terms of such statutes are mandatory, and a contract which fails to meet the requirements prescribed is not enforceable against a municipality.

The recommendation therefore is that contracts entered into with public authorities should be in writing and should comply with the statutes and contain all the necessary signatures.

SAMUEL I. SACKS

Philadelphia, Pa.
Feb. 15, 1937.

Wrought Iron Adopted in Greenhouse

Sir: Your excellent article on the "jewel box" greenhouse in St. Louis, Feb. 25 issue, might be supplemented by the remark that wrought iron was used extensively in the building. Mr. Becker felt the need of corrosion-resisting material not only in the piping but also in the window sections, because of the tropical or semitropical conditions that would obtain in the greenhouse.

To the best of my knowledge this is the first greenhouse in which wrought iron has been used so extensively, though for many years wrought iron pipe has been used largely in the steam and water piping of such structures.

G. B. CUSHING,
A. M. Byers Co.

Pittsburgh, March 3.

A.C.I. Building Code

Sir—In the report of the convention of the American Concrete Institute in the March 4 issue, where reference is made on page 343 to the A.C.I. Building Code, it might be inferred that the code committee has already taken action in the matter of making certain changes in its recommendations regarding spirally reinforced and tied concrete columns. Actually the committee only presented a statement relating to amendments which it expects to propose this spring to the entire membership of the institute. These amendments will relate to Section 709, Chapter 7, referring to "slabs supported on four sides," and to Chapter 11, relating to "reinforced concrete columns."

R. R. ZIPPRODT
A.C.I. Committee 501,
Secretary.

New York City.
March 12, 1937.

The Fourth Dimension

Sir: Your editorial, "The Fourth Dimension", in *Engineering News-Record* of Feb. 25 is thought-provoking.

Nothing is more true than what Emerson said, "An institution is the lengthened shadow of a man." We ponder over industrial strife and social uplift. We try to reason, why?

We need more men motivated by what you call the fourth dimension, "the influence that knits the working body of men into true organization." Simply, men who appreciate the interdependence of those men who do the work of the world, and who recognize real equity in sharing the results of joint effort. This is true organization.

It is heartening that signs are increasing which show that America is on the march in this direction—to safety.

H. O. LOCHER
The National Association of
River and Harbor Contractors

New York, N. Y.
March 3, 1937.

Electric Conduits and Floors

Sir: The practice of structural engineering has improved greatly since the day when the usual floor construction was a tile arch sprung between the beams. In those days the beams were placed flush bottom and a filling of concrete was used to bring the floor to a level surface above the top flanges. This resulted in a fill with a depth of 4 to 8 in.

At that time most of our building codes were born. The burning of a great number of so-called "fireproof" buildings caused a very conservative reaction on the part of the profession, and fireproofing restrictions were adopted which became a serious drag to the building industry for many years. It was also at this time that electric wiring codes were written. The concrete floor fill offered a convenient place for conduits and boxes. These were of generous size because the use of electric energy was something new, and the skill of the artisans had not been developed to its present standard.

In the last fifteen years, however, the practice of the structural engineering profession has steadily been toward a lighter and thinner floor. We have now reached the point where further progress in this direction would seem to require help from our friends in the electrical profession. I know next to nothing about electrical engineering, but it does seem that a conduit of close to 1 in. diameter is not necessary to carry two wires of about ⅛ in. each. The size of the conduits usually means that there is an effort to get from 2 to 2½ in. of fill in order that two conduits might cross each other. This results in a large increase in dead weight and thickness of the floor systems. The size of outlet boxes also seems to be excessive. I know of one recent case of a library bookstack where the floors intended to be 3 in. thick had to be made 3½ in. in order to get sufficient depth for reinforcement and outlet boxes.

Of course there are legal restrictions

in the codes which may limit the physical dimensions of electrical devices at the present time. Structural engineers, however, found the same difficulty when they set out to improve their standards, but through concerted action and the right kind of publicity they have made encouraging progress in the direction of more reasonable building codes. There seems to be little reason why the electrical profession cannot do the same thing.

MONROE AMES
Structural Engineer,
Allen, Collens and Willis, Architects
Boston, Mass.
March 5, 1937

2,000-lb. Concrete

Sir—My attention has been called to the editorial published in your issue of March 4, 1937, under the title "But Why 2,000-lb. Concrete?" As a member of the "Joint Committee" and of the sub-committee on "Proportioning, Mixing, Curing and Testing Concrete," I feel it proper for me to reply to your question.

The statements in your editorial are, apparently, based entirely upon the table of concrete strengths at the top of Table 8 on page 44 of the Joint Committee "Progress Report." This report was distributed by the American Concrete Institute last month. In this table there is listed a concrete with a strength range of from 2,000 to 2,400 lb. per sq.in. However, the sole purpose of this table is to guide the designer in the proper choice of the modular ratio, *n*. There is nothing in the table to indicate that the committee recommends the use of 2,000-lb. concrete for structural elements which are subjected to "frost action and corrosive water exposure," as stated in your editorial.

It is pertinent to suggest that the progress report of the Joint Committee should be read as a whole and that the full import of the committee recommendations can not be obtained by isolating one statement from its context. Reference to Tables 2 and 3 on page 7 of the report reveals that the committee indicates a maximum allowable net water content of 8½ gal. per sack of cement for 2,000-lb. concrete. Next, reference to Table 1 on page 6 of the report shows that for a structure exposed to even the mildest climatic effects the maximum water content is 7½ gal. per sack, which, on the basis of very conservative values (as indicated by Table 3 of the report) should result in not less than 2,500-lb. concrete.

In other words, if the recommendations of the committee are followed, the 2,000-lb. concrete to which you object would be used only "for concrete not exposed to weather" where "no exposure hazard is involved." (see Table 3, footnote *b*, of the committee report). There is no occasion for alarm in regard to the recommended uses for 2,000-lb. concrete. If the maximum water contents recommended by the committee in Table 1 are used, the 28-day strength of the poorest concrete exposed to the weather will be considerably in excess of 2,000 lb.

Concrete with a maximum water content of 8½ gal. per sack of cement corresponds to the class "B" concrete of Specification 13Yc of the Bureau of Yards and Docks, Navy Department. We have had fairly frequent occasion to use such concrete. If it is properly made and is not exposed to deteriorating influences, there is no reason why it should not be counted upon to sustain the stresses recommended by the committee.

I note your statement that "a working stress of 800 to 1,000 lb. per sq.in. is allowed on such concrete." I see no statement in the report to indicate that a working stress of 1,000 lb. per sq. in. would be permitted on 2,000-lb. concrete.

BEN MOREELL,
Commander, (CEC) USN.
Washington, D. C.
March 17, 1937

COMMANDER MOREELL is perfectly right in maintaining that the Joint Committee report should be read as a whole. If it is, the limitations to the use of 2,000-lb. concrete are found to be clearly stated. But 2,000-lb. concrete is not good concrete measured by modern standards regardless of the service for which it is intended. Although it can be used safely and satisfactorily under adequate technical supervision it does not seem proper that its wide use should be encouraged. With respect to working stresses, these are recommended as 0.4 of the 28-day cylinder strength, which for the 2,000–2,400 lb. class concrete gives 800 to 960 lb. per sq. in.

EDITOR.

Relaxation of Constraints— A Method of Frame Analysis

Sir: The structural engineer is in possession of comparatively rapid and easy methods, graphical and analytical, for calculating the stresses in space frameworks which may be reduced to two dimensions. Although these include many classes of structures encountered in practice, they do not include others, especially airships and airplanes.

R. V. Southwell, Professor of Engineering Science at Oxford University, England, has devised a method applicable to the analysis of space frameworks which, it is believed, is not as widely known in the United States as it deserves to be. In effect it obtains the solution of simultaneous equations by a process of successive approximation of the sort with which the Hardy Cross method of moment-distribution has already made the engineer abundantly familiar. The process consists in imposing imaginary constraints on any or all of the joints of the framework so that they will sustain the whole force at every joint. Next, imagine that one constraint is relaxed so that one joint is permitted to travel slowly through a specified distance in some specified direction. The force will be transferred from the constraint to the framework and, since all joints but the one are fixed, it is an easy matter to calculate what displacement will be necessary to transfer a given force. Next, let the constraint be rigidly fixed in its new position, and another relaxed. The process may be continued until the desired approximation is reached. The forces in each member may then be calculated from the joint displacements. Once the method has been grasped, its actual operation is a matter of "engineering bookkeeping," and Professor Southwell has suggested special devices, such as relaxing blocks of joints together, which accelerates the rate of approximation to the desired result.

This method has a wide range of application including problems in which;

(a) the framework is three-dimensional.

(b) the members are connected either rigidly or by frictionless joints at either end.

(c) the members are so orientated that torsional as well as flexural rigidity comes into play to resist distortion.

(d) the forces are applied either at joints or to the members at any intermediate sections.

(e) any degree of rigid constraint is imposed.

For details of the method, those interested are referred to Professor Southwell's paper, "Stress-Calculation in Frameworks by the Method of Systematic Relaxation of Constraints," appearing in the Proceedings of the Royal Society of London, Parts I and II in Vol. 151, Series A, 1935, pp. 56-95 and Part III in Vol. 153, Series A, 1935, pp. 41-76.

DAVID C. WILLIAMS
Mechanics Department
Ohio State University
Columbus, Ohio
March 15, 1937

Concrete X-Ray Room

Sir: So many inquiries have been received regarding the article "Concrete X-ray Room Built Without Lead Lining" (ENR Nov. 5, 1936 p. 648), that it is thought best to call your attention to the fact that an aricle fully covering the subject was published in the Transactions of the Electrochemical Society, (Colin G. Fink, Secretary, Columbia University, New York City) Vol. 1 LXIX, 1936, by Hanson, Christensen, and Cochran.

I also want to call your attenrion to an error in the ninth line of the third column on page 648 which reads, ". . . Amperes at a point 25 ft. from the . . ." This should read, ". . . Amperes at a point 30 in. from the. . . ."

A. C. HANSON
Director of Research,
Rock Island Arsenal
Rock Island, Ill.
March 14, 1937

ENGINEERING NEWS-RECORD

Volume 118, No. 13.

Copyright, 1937, by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, C. S. Hill, H. W. Richardson, E. J. Cleary

Editorial offices at 330 West 42nd Street, New York

April 1, 1937

Acknowledging a Debt

THE WORK of the technologist in materials is coming to be better understood in roadbuilding. At the five major highway conventions held in the last three months soils and surfacing materials received most attention, and the discussion was led by the technologists. These men are giving a remarkable service to roadbuilding. Today cement, brick, bitumens and even the soils of the earth are vastly more controllable in the service of the designing engineer and constructor than they were even a year ago, because of the diligence of the man of retorts and testing machines. He seldom appears publicly before others than the members of his own brotherhood; the road-using public scarcely knows that he lives and works. But every engineer in the field is doing his work more surely because of the technologist in materials, and it is full time that an acknowledgment of that service should be recorded.

Road Lighting Sublime

LIGHTING AS PRACTICED on the Bay Bridge is a fitting accessory of that monumental structure, but its proportions are almost grotesquely large when applied to the problem of lighting highways generally. It is a bit staggering to learn that to light less than twenty miles of roadway called for the investment of more than half a million dollars and a yearly operating cost of $40,000; such figures will not fit normal highway needs. It is true that much less elaborate lighting would be adequate for the ordinary road, or even the arterial road; nevertheless even the reduced costs are still so large as to be a deterrent to road-lighting progress. If we consider also that placing lights along a road does not in itself produce a lighted road, the difficulties faced by the highway engineer in seeking to provide lighted roads become apparent. The Bay Bridge installation is not normal road lighting but road lighting sublime. While it shows what lighting can do to free the night road of danger, it contributes little to forwarding the cause of lighting roads in general. But the encouraging thing is that many men are working actively toward the solution of both road and lamp problems, and we are every day moving nearer to ultimate realization of the lighted road.

Pressure-Pipe Economics

CONVENTIONALLY, pressure pipelines have been regarded as simple problems of strength design; the extent to which economic factors affect their best layout and proportioning has been realized but rarely. For this reason the discussion of pressure-pipe economics by Julian Hinds, which we published last week, adds an important chapter to the literature of hydraulic conduits. While his method finds primary application to siphons that descend into deep valleys, it is not limited to this case, for few pipelines are so located that all parts of their length are under the same head. Wherever the pressures differ sufficiently to make it likely that money can be saved by reducing the size of the high-head sections, the Hinds procedure will prove greatly preferable to detailed comparative estimates. Of course the operating value of a foot of head must be determined correctly, and all the conditions of flow and of terminal control must be taken into account. In short, practical forethought and judgment are important here as they are in other engineering design. So supplemented, the rational procedure now made available will prove an essential addition to the conduit designer's equipment and will help to improve pressure-line construction.

"Elevation as of 1936"

SUBSIDENCE OF THE EARTH'S SURFACE in a 200-sq.-mi. area where 110,000 people reside is one of the leading topographic and geoligical mysteries of the age. In time it may prove to be something more than a mere matter of scientific interest, for the area includes a populous city. The city of San Jose is only a few miles from the San Andreas fault, on which lateral earth movements of several feet occur from time to time, as in 1906. Perhaps gradual loss of a few feet in elevation is of little concern to people who know about and to some extent expect seismic movements. But local opinion does not ascribe the subsidence to seismic causes; other explanations are preferred, such as the fact that some soils shrink when water is drained out of them—and it is well known that the water table in the San Jose region has been lowered by pumping. To date the city's services have not been disturbed. Sewer grades are not extremely flat, and as the subsidence is rather gradually distributed no pipes have been broken. Whether future service disturbances will develop remains to be seen. Whatever its cause, the phenomenon warrants further study; the record of settlement published in this issue is only a progress report. Meantime, in view of the progressive change of levels it appears necessary to quote elevations of points in the area not as fixed quantities but as quantities of a specified date, thus; "Elevation 92 ft. as of 1936."

Fast Work

RAPID COMPLETION of large construction projects is the rule today rather than the exception, but even so an occasional job stands out as a remarkable achievement for speed. Such a job is that of grading the site of the New York World's Fair, just completed ten days ahead of a contract time stipulation that seemed incredible at the start last June. The requirement was to remove 6,000,000 cu. yd. of ashes from a 35-year old rubbish heap and spread them over 780 acres of swamp land to a depth of 4 to 10 ft., dredge out a million yards of muck to create two artificial lakes, and save the spoil for topping the ash fill. To meet the grading schedule the contractor had to set his daily production at 54,000 cu. yd.—a lot of ashes and muck to haul an average of 4,000 ft.! That this heavy schedule was maintained in the face of most adverse weather conditions is a tribute to advance planning, organization, and selection and care of equipment. When an open winter denied him the expected consolidation of fill material and swamp mat by freezing, the contractor was forced to carry on through a quagmire. Haulage units mired down as temporary roads sank into the swamp, and they skidded their way across slick borrowpits. Yet through it all the trucks and motor wagons somehow stood up and shuttled unceasingly from shovel to fill over planked roadways lighted at night by

the most elaborate floodlighting system ever set up on a construction job. Two years from now as the public passes through the fair grounds and buildings it will have little appreciation for the muddy fight; the construction world will remember it as a tough job done in fast time by able planning and determination to win.

Twenty Years

IT IS HELPFUL from time to time to look backward, if only to obtain a better understanding of present and future. This week, as *Engineering News-Record* rounds out the second decade since *Engineering News* and *The Engineering Record* joined hands on April 5, 1917, a retrospective glance at the changes that the twenty years have brought to engineering construction is but natural.

Structures of unsurpassed magnitude and difficulty have risen in that time. The bridgebuilder's art, the work of the building erector and of the foundation constructor, have gone forward in steady advance. The early twenties, after the ending of the war's disturbances, ushered in the era of the superskyscraper and the greatest period of large bridge and dam building ever known, culminating in the Empire State Building, the huge spans across the Hudson and San Francisco harbor waters, and Owyhee, Boulder and Grand Coulee dams.

Steel practice, twenty years ago just beginning to depart from the soft-steel age, moved consistently toward high-strength alloys. Structural welding was born and grew to large stature. The liquid concrete obsession yielded to dense, strong and durable concrete founded on scientific research. Even timber construction, despite its limited opportunities, moved forward to larger service by aid of plywood, ring connectors and improved grading.

In other fields still more sweeping change occurred. Revolutionized by laboratory and model research, hydraulic engineering made perhaps the most rapid advance in its history. River control has been transformed; the Miami River improvement was followed by the tremendous Boulder Dam-Imperial Valley undertaking, by the epochmaking straightening of the Mississippi through cutoffs, by gigantic strides in turbines, by achievement upon achievement in channels, dams, spillways and power undertakings. Transportation saw the whole concept and realization of a new national highway system into being. Road transport grew from faint beginnings to its present huge dimensions, and air transport took a place by its side.

But perhaps nowhere was more rapid and purposeful advance achieved than in the construction art itself. Tools of new scope and power, methods revolutionized by the resourcefulness of constructors and by such aids as the motor truck, the road grader and the steel sheetpile, more than kept pace with the progress of engineering skill. Boulder Dam as well as our highway system, the Holland Tunnel, Fort Peck and the George Washington Bridge, were made possible through the remarkable growth in the power of construction methods and machines.

Also, well within the twenty years, soil science took its place in engineering, with results of which we have seen only a beginning. The economic aspects of engineering, from being only academic matters, became practical realities. We learned that construction is near the heart of our entire mechanism of living and doing business, and that public works concern even the ordinary citizen.

A short time in the 63 years since the foundation of this journal and a vastly shorter time in the history of man's constructive efforts, these twenty years have seen greater advance in the civil engineer's art than any comparable period of the past. The present rate of advance justifies the prediction that fully as great a change will take place in the next two decades. *Engineering News-Record*, whose pages week by week have mirrored the work of the past twenty years, looks forward with hope and anticipation to recording the progress that is to come.

Toward New Road Systems

DEFINITE PLANS are beginning to emerge from highway department thinking on express highways. Early last month Commissioner John A. Macdonald of Connecticut sounded the boldest note in highway progress that this provident New England state has yet heard, by asking enabling legislation for a $100,000,000 express road extending diagonally across-state from New York to Massachusetts. In a report to the New York legislature Frederick Stuart Greene, superintendent of public works, now urges a system of half-a-score of new highways traversing the state, to cost $300,000,000.

Both of these projects have been subjects of department consideration for some time, but only now do the demands of transport make the authorities bold enough to announce them and ask for legislative approval. The requests will probably stir up sharp discussion, and final action promises to be slow. New York in particular has been willing to let its highways fall behind current standards of improvement while its millions of public-road funds were being diverted to other purposes. It may continue for a time to neglect necessary road modernization, but it cannot do so for very long.

The plain fact is that growing transport needs have at last brought express-highway plans openly before the public. The need of the arterial highway has long been clearly evident, but the public, slow to change from traditional attitudes, still has to be educated. Here is the task that lies before highway interests; neither in their association activities nor in individual effort can they afford to neglect the duty of carrying it out.

Perhaps the strongest popular prejudice to be overcome arises from the belief that such roads are extravagant speedways, designed to serve the luxurious few. No *autostrade* are wanted in America, it is asserted. Admitting this to be true, there has been no purpose in New York or Connecticut planning, or for that matter in public-roads thinking elsewhere, of developing exclusive-service highways. The new roads are proposed for general traffic, with restriction only on local traffic. Multiple lanes are to provide for fast and slow traffic, while local traffic will have the use of improved existing roads plus access to the express routes for its through service.

Express roads are the logical forward step in main-road development; their planning should be the set purpose of highway administrations. Construction will be a matter of many years at best, but system planning should be begun at once. As the Connecticut and the New York highway departments have done, other state road departments should proceed to initiate such planning. The opportunity before the highway engineer to make real progress is great; it should not be neglected for other hands to grasp.

CURRENT NEWS

Potomac Laboratory For Pollution Urged

Potomac state officials meet to consider making river national laboratory of pollution control.

Organization of a permanent committee to report on methods for developing a Potomac river basin laboratory for the study of anti-pollution methods was the first step taken by a recent conference of officials of a number of the Potomac states held at the United States Chamber of Commerce in Washington. The conference was called by the Washington Board of Trade to consider the conclusions reached in a recent report of the National Resources Committee recommending an appropriation by Congress of $15,000,000 for an interstate and federal program of pollution control on the Potomac river, which might serve as a demonstration project for the nation as a whole. Dr. R. H. Reilly, director of the Maryland State Board of Health, was chosen chairman of the committee.

Resolutions calling for national cooperation in the abatement of river pollution and in carrying out the recommendations of the National Resources Committee were passed at the conference. It was asserted by speakers who favored the proposal that the Potomac river had been selected as a national anti-pollution laboratory because the number of sewage and industrial waste problems involved is typical of modern problems elsewhere in the country. Some opposition was evidenced immediately after announcement of the proposal, and opponents charged that industrial wastes, so important in other localities, were slight on the Potomac river.

It was asserted that a large amount of data had been collected within the past 25 years relating to the Potomac and "this data would enable engineers to go into the matter armed with all the necessary and pertinent facts."

—⟡—

Grading for New York Fair Ends Ahead of Schedule

The grading of the site of the New York Worlds Fair, involving excavation of 6,000,000 cu. yd. of ashes and rubbish and 1,000,000 cu. yd. of swamp muck, was completed on March 20, ten days ahead of contract schedule. The job, started last June 15, required the spreading of a 35-year accumulation of ashes over 780 acres of Flushing Meadows swamp land and the dredging of two large lakes and a new channel for the Flushing River. Grading operations were handicapped by the wet, open winter, for the contractor had counted on freezing of the ash dump making the material easier to handle. Instead, frequent rains turned borrow pits and fills into quagmires. A description of the grading work was published in *ENR* Oct. 22, 1936, p. 565. The contract was carried out by the Arthur A. Johnson-Necaro Corp., under the direction of A. D. Saunders and William Beattie, for the Park Department of New York City, which will take over the site after the fair is over.

Construction of the fair buildings has started with pile driving for the administration building, being done by H. Johnson & Son, Flushing, N. Y., as subcontractor for the James P. Rice Building Co. Western timber piles from 90 ft. to 110 ft. long are being used.

—⟡—

PWA Makes Grant to Florida For St. Johns Bridge

PWA has made an outright grant of $293,250 to the state of Florida to cover part of the $1,538,000 cost of constructing a new vehicle bridge across the St. Johns River in Jacksonville. The rest of the cost has already been covered by bonds which are being taken over by the state highway department.

The total length of the bridge will be 1,866 ft., exclusive of approaches, and it will be 42 ft. wide with two 5-ft. sidewalks. A navigation span will provide a horizontal clearance of 350 ft. with a 40-ft. vertical clearance when closed and 135 ft. raised. The bridge, a vertical lift span, will be entirely of steel except for the concrete piers.

When completed, the bridge will be operated as a free bridge by the state highway department. Contractor on the bridge is Duval Co. Harrington and Cortelyou, Kansas City, Mo., are the consultants.

—⟡—

Second Housing Bids Called For Evansville Project

PWA has re-advertised bids for construction of the superstructure on Lincoln Gardens, $1,000,000 slum clearance project in Evansville, Ind. Opening of bids will take place in the Washington offices of the Housing Division May 4.

First bids on the project were rejected last October by the Housing Division (*ENR*, Nov. 5, 1936, p. 662) on the grounds that they were too high. At that time redesign of the project and revision of the plans in order to lower cost was ordered.

The revised plans call for an increase in the number of living units in the project from 138 to 191. The project will consist of group houses mostly two stories high of brick veneer construction. Each dwelling unit will have individual heating.

The Housing Division states that, according to the Red Cross, the present housing shortage in Evansville has been increased 20 per cent by the flood.

N. Y. Water Tunnel Work Begins

Ceremonies attend firing of first blast at Shaft 3 of New York City's Delaware River Aqueduct

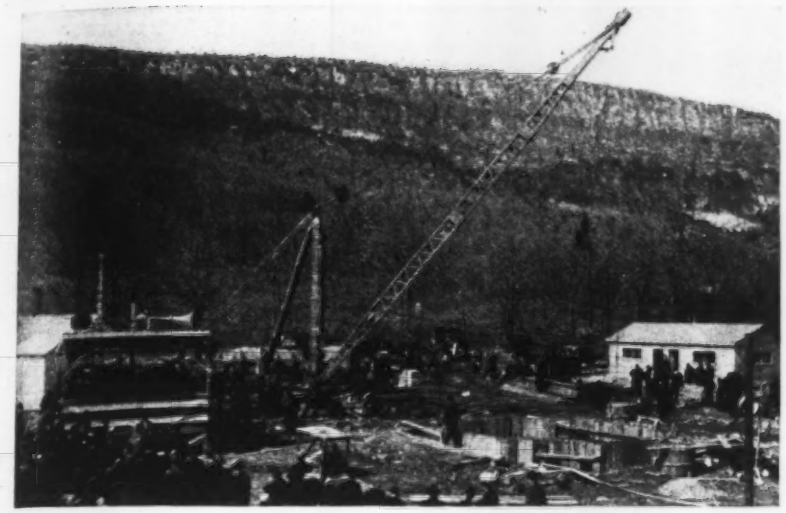
Four delayed shots fired by Mayor LaGuardia at noon March 24 sent the dirt flying from Shaft 3 and marked the official start of construction on New York City's new Delaware River aqueduct project. The firing of the first blast was part of the opening ceremonies conducted by the Board of Water Supply at the foot of Shawangunk Mountain, near the upper end of the new water supply system, in the presence of state and city officials and some 500 guests. Thirty years ago next June 20 similar ceremonies were held at Cold Spring, N. Y., starting work on the great Catskill aqueduct project. The late J. Waldo Smith was chief engineer of the Board at that time, and the present chief engineer, Walter E. Spear, was a division engineer in charge of part of the construction. Mgr. Michael J. Lavelle holds the distinction of pronouncing the invocation at both ceremonies.

The Board's engineers felt that it was fitting to hold the ceremonies at one of the shafts being sunk by the contractor who sunk more than half of the shafts on the Catskill project, the Dravo Contracting Corp. of Pittsburgh. Dravo holds the contract for three shafts at the upper end and seven at the lower end of the Delaware River system.

Prior to the shot at Shaft 3, George J. Gillispie, president of the Board of Water Supply, paid a tribute to Thaddeus Merriman, former chief engineer and now a consultant to the Board, and to Arthur J. W. Hilly, former corporation counsel, for their work in carrying the project through years of litigation with neighboring states and to the present staff of engineers for their part in development of the new water supply. Mayor LaGuardia also paid tribute to the engineers and contractors, remarking that, "If my profession, the legal profession, had not fallen so far behind the engineering profession, the expensive and long drawn out litigation would have been wholly unnecessary." He went on to say, "This project we are starting today will stand for centuries. Aqueducts built by my ancestors in Rome have served through the ages."

Both Mr. Gillispie and the mayor pointed out the need for additional water supply and cited the backing obtained from most state and civic bodies. However, one discordant note was injected by a statement from Controller Taylor, read by one of his staff, calling for "a complete survey of present plans by an outside body of engineers to make sure we are on the right track." The engineering staff of the Board and the consultants include many of the best-known water engineers in the country.

Contracts have been let for all but seven of the 30 shafts required for the 85-mile



START OF WORK on New York's Delaware River aqueduct system was marked by ceremonies at Shaft 3 on Mar. 24, at which Mayor LaGuardia fired the first blast after paying tribute to the engineers responsible for the new water supply project. This view was taken just before the mayor pulled the firing switch from the speakers stand at the left.

tunnel. Dravo has two contracts for thirteen shafts, $5,846,813. A. T. Gott is in general charge for Dravo; R. W. Remp and the veteran Arthur C. Dennis are superintendents of the two contracts. W. E. Callahan Co., Dallas, Tex., has five shafts, a $1,926,150 contract; H. L. Crawford is construction manager. Frazier-Davis Const. Co., St. Louis, has just been awarded four shafts for $2,294,415, and has not as yet announced who will be in charge.

The remaining seven shafts will probably be let along with the tunnel contracts. A summary of the feature of the project and the shaft work was given in *ENR* Jan. 14, 1937, p. 41.

Montana Department Merger Vetoed by Governor

Governor Ayres of Montana has vetoed a measure passed by the state legislature which proposed to consolidate the state highway department with the water conservation and planning boards (*ENR*, March 11, p. 390). The governor took this action after PWA officials had advised him that the merger would retard the progress of important water conservation projects in the state. Water conservation bonds, now sold to the PWA for resale, could not be purchased by the PWA, under the new measure, until the expiration of the six months period allowed by the state constitution during which petitions for a referendum on the bill could be submitted. If during this period the necessary 5 per cent of the state's registered voters should petition for a referendum, then PWA would not be able to purchase the bonds until after the next biennial general election.

Governor Ayres stated that he would have approved the measure if the bond situation had not been involved in so many difficulties.

Power Drop Contracts Let For All-American Canal

The Department of the Interior has announced the award of contracts covering construction of concrete drops and power plant substructures at four points on the All-American Canal for a total of $809,830.80. Contract for construction of drops and substructure at sites Nos. 1 and 2 was awarded to the Pleasant-Hassler Construction Company of Phoenix, Arizona, on its bid of $410,896.50, while the contract for construction of the drops and power plant substructure at sites Nos. 3 and 4 was awarded to Frank J. Kernan and John Klug of North Portland, Oregon, on their bid of $398,834.30.

The structures to be built at these four sites are similar in design except that the construction at power drop No. 5 will include, in addition to drops and powerhouse substructure the construction of the turn-out structure for the New Briar Canal. Each power drop will be provided with spillways. The substructures of the power houses will rest on wood pile foundations.

The Imperial Irrigation District is expected to construct and equip the power houses. It has obtained a PWA loan and grant of $2,760,000 to construct the power house superstructures and install the necessary turbines and generators at power drop No. 4, at which the highest head can be developed.

The canal falls approximately 51 feet at power drop No. 4, and the power plant to be constructed there will have an installed capacity of 24,000 kw. The installed capacity at each of drops Nos. 2 and 3 will be 12,000 kw. with a 26-foot head, and at drop No. 5, 6,200 kw. with a 24-foot head. Installation of the generating machinery at drops Nos. 2, 3 and 5 will be undertaken at a later date according to the plans of the irrigation district.

The power drops are located east of Calexico, California, and west of the sand hills west of Yuma, Arizona.

First Construction On Central Valley

Construction of a section of the Contra Costa Canal is the first award on the $170,000,000 Central Valley project

Award of the first contract for actual construction on the Central Valley federal reclamation project in California, covering excavation and structures on the first section of the Contra Costa canal has been made to Haas, Doughty & Jones and Marshall & Stacy, of San Francisco, Calif. on their joint bid of $102,000. The successful bid was the lowest of 25 received by the Bureau of Reclamation March 1.

The Contra Costa canal is a major feature of the Central Valley project. It will extend from the west end of Rock Slough near Knightsen, Calif. more than 20 miles west to the vicinity of Martinez, Calif. The contract approved today covers that section of the Canal between the end of Rock Slough and the town of Oakley.

The canal, with a capacity of 275 sec. ft., will supply supplemental irrigation water to the Walnut Creek-Concord area of Contra Costa County and industrial and domestic water to the cities and factories on the south side of Suisun Bay, where intrusion of salt water from San Francisco Bay has caused great damage. The cost of the Canal is estimated at $2,200,000. Water users to be served by the Canal will repay the cost of construction without interest in 40 years, under contracts negotiated by the Bureau of Reclamation and the State Water Authority. The section of the Canal covered in the present contract will be 24 ft. wide at the bottom and will involve excavation of about 640,000 cu.yd. of earth. Construction of four concrete syphons and a number of small timber bridges is also included. Work will begin within thirty days after the contractor is notified to proceed and must be completed within 330 calendar days.

Contracts previously awarded on the Central Valley project have consisted of such work as exploration of foundations for dams and other pre-construction work.

The Central Valley project consists of two divisions in addition to the Contra Costa division. These are the Friant division in the San Joaquin River basin and the Kennett Division in the Sacramento River basin. The total cost of all phases of the project, which is designed to regulate and conserve the water of both the Sacramento and San Joaquin rivers is estimated at $170,000,000.

South Africa Launches Program For Capetown Harbor

The South African government has decided to allocate $11,250,000 immediately for harbor development at Capetown. The work to be started includes the construction of a random mole nearly 7,000 ft. long across the corner of Table Bay and the reclamation of 363 acres of shallow water.

The completed project, which will cost $50,000,000, will add 290 acres to the 196 acres of the present new basin in the dock and will involve extensive replanning of the lower part of Capetown.

Stream Pollution Hearings Held

Washington correspondence

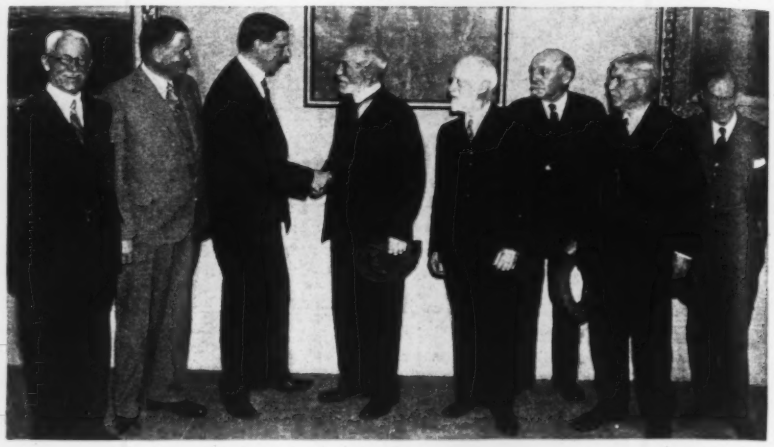
Hearings before the House Rivers and Harbors Committee have been held on a number of bills dealing with the subject of stream pollution. The Lonergan bill has not reached the House as yet, but the Pfeifer bill (HR 3419) which is similar to the Lonergan measure, was among those considered, as was the Vinson bill (HR 2711).

The Pfeifer measure provides, as does the Lonergan, for stringent and mandatory federal control of the whole pollution problem, but it has been criticized as lacking the needed powers for its proper execution.

The Vinson bill would appropriate funds for the investigation of the pollution situation and for cooperative work with local agencies. The authority for carrying out the provisions of the proposed measure would be placed in the hands of the federal Public Health Service. Funds also would be provided to aid states in conducting further investigations of their own pollution problems, especially those arising from cities and industries. Federal assistance in the construction of public and private treatment plants would be given under the proposed measure.

Among those testifying in favor of the Vinson measure were Senator Barkley, who is author of the companion Senate bill (S 702), Surgeon General Parran, and Abel Wolman of the National Resources Board. Senator Lonergan also appeared but confined himself to stating his belief that the only solution of the problem was to be found in mandatory federal control.

Prospects for the passage of a stream pollution measure at this session appear to be excellent, and substantial support is being given the Vinson measure by business and industry.



PROF. MARX OF STANFORD HONORED BY ALUMNI

"When a man has the love and affection of his associates to this extent," said President Wilbur, of Stanford, "he has the highest tribute that can be paid by his fellow men." Dr. Wilbur was speaking with his hand on the shoulder of C. D. Marx, emeritus professor of civil engineering, Stanford University, at a luncheon preceding the viewing of an oil painting of Professor Marx just hung in the Stanford art gallery. Dr. Wilbur had spoken of the 46 years in which Professor Marx has been connected with Stanford, of his most unusual record for sympathetic helpfulness to students during their undergraduate days and his keen interest in their progress as graduates; of his contributions to the solution of national engineering problems and of the long list of honors that have come to him, including presidency of the A.S.C.E.

The photograph of the dedication ceremony shows, left to right, A. T. Murray, S. B. Morris, Ray Lyman Wilbur, C. D. Marx, W. F. Durand, C. B. Wing, L. M. Hoskins, Frank Angell.

Florida Engineers Ask Change In Registration Law

The Florida Engineering Society, meeting March 18-20, at Tampa, Fla., unanimously adopted a new registration law to be presented for consideration to the state legislature. The proposed bill specifically exempts military engineers and architects from its provisions and does not include operation of plants or machines. It requires that public and municipal construction work and design be under the supervision of engineers registered in Florida. It increases the powers of the registration board to subpoena and administer oath to witnesses and gives the board authority to cancel certificates of registration in cases involving malpractice and unprofessional conduct.

A discussion of the use of plane coordinates in surveying by Russell De Grove was followed by the presentation, by the committee on surveying, of a proposed bill to describe and officially name a system of coordinates for the state of Florida and to legalize descriptions of land boundary lines and corners in terms of the coordinate system. This bill was adopted by the meeting.

Also adopted was an amendment to the constitution of the society setting up the grade of Fellow. Under the terms of the amendment corporate members are divided into Fellows and Members, a Fellow being a registered engineer of distinguished attainments with at least 20 years of active practice and at least ten years of membership in the society.

A. L. Pfau, Jr. was elected president, and H. J. Morrison first vice-president. B. R. Van Leer becomes second vice-president; W. W. Fineren, secretary; and H. D. Mendenhall, treasurer. J. H. Dowling and J. W. Keck were elected directors.

Louisville Department Store Repair Contract

In the article describing the rehabilitation of the Ohio Valley following the recent floods, published in *ENR* March 11, 1937, p. 380, the H. F. Friestedt Co. of Chicago was mentioned as contractor on the repair of the Kaufman-Straus department store in Louisville, damaged by settling foundations. The name of the contractor is in error; the work was done by the L. P. Friestedt Co., shoring and building moving engineers of Chicago, which has no connection with the H. F. Friestedt Co. Repair work consisted principally of jacking up all the interior columns of the six-story building and replacing the original small brick piers with concrete spread footings.

Strength of Materials Studied At Special Summer School

A special summer school and conferences on the strength of materials will be held at Massachusetts Institute of Technology for the four weeks from June 21 to July 16. Emphasis in the course will be placed upon the subjects of creep and fatigue of metal.

The subject of creep will be presented by Dr. A. Nadai, consulting engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh. Dr. Nadai is well known for his work on plasticity and particularly for his text on the subject. In 1931 he gave the Marburg lecture before the American Society for Testing Materials; he is a member of the Applied Mechanics Division of the American Society of Mechanical Engineers. The last two lectures of the creep series will be given by C. R. Soderberg, manager of the steam turbine department, Westinghouse Electric & Mfg. Co., in which design applications using plasticity theory will be discussed.

The lectures on fatigue will be given by Dr. H. J. Gough, superintendent, engineering department, National Physical Laboratory, England. Dr. Gough is the author of the book "Fatigue of Metals," and in 1933 was invited to this country to give the Marburg lecture before the American Society for Testing Materials.

The tuition fee for the course will be $80. The graduate school of M.I.T. will allow credit for 9 units of advanced study for the completion of this special summer school program. Further particulars may be obtained from Prof. John M. Lessells, department of mechanical engineering, Massachusetts Institute of Technology.

Wide World Photo

GERMAN ROADBUILDING MACHINE

This new machine, developed in Germany for use in the building of highways and demonstrated at the Leipzig Trade Fair, stamps the top soil on the road into a smooth surface, replacing rollers as a means of compaction. This machine appears to have a rocking action rather than the leaping motion of the Delmag Frog, another German compactive device, described in *ENR* May 14, 1936.

World's Fair Salaries Raised In F.A.E.C.T. Negotiations

Salary increases averaging $10 per week have been granted by the World's Fair Corporation, New York City, to its field engineers. The salary adjustments, effective April 1, provide a scale of $50 to $55 per week for chiefs of party, replacing a scale of $35 to $40. Instrument men and engineers' assistants also receive advances in pay.

Establishment of the new salary scale followed conferences between officials of the Fair Corporation and of the New York chapter of the Federation of Architects, Engineers, Chemists and Technicians. The Federation had been given authority by all the field engineers to represent them in negotiations for salary increases.

—⟡—

Building Congress Endorses Beiter Bill

A special committee of the New York Building Congress which has been making a study of the revenue act of 1936 for the purpose of formulating plans for a suggested revision of the act with respect to the surtax on undistributed profits decided at a recent meeting to recommend endorsement of the Beiter bill, which was introduced into the House of Representatives on Feb. 10 at the request of the Associated General Contractors and is now pending in Congress.

The bill would exempt from the excess profits tax of 27 per cent undistributed profits which were utilized for new construction or plant expansion.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, San Antonio, Texas, April 21–24.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., April 26–27.

NATIONAL LIME ASSOCIATION, annual convention, Chicago, Ill., May 11-12.

BUILDING OFFICIALS OF AMERICA, annual convention, Cleveland, Ohio, week of May 31.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Buffalo, N. Y., June 7-12.

AMERICAN WATER WORKS ASSOCIATION, INDIANA SECTION, Indianapolis, Ind., March 25-26; FLORIDA SECTION, Ocala, Fla., March 30-April 1; KENTUCKY-TENNESSEE SECTION and SOUTHEASTERN SECTION, joint meeting, Chattanooga, Tenn., April 5-7; CANADIAN SECTION, Montreal, Canada, April 14-16; MONTANA SECTION, Lewiston, Mont., April 19-21; FOUR STATES SECTION, Philadelphia, Pa.; April 22-23; ILLINOIS SECTION, Springfield, Ill., April 29-30; PACIFIC NORTHWEST SECTION, Victoria, B. C., May 20-22.

AMERICAN SOCIETY FOR TESTING MATERIALS, PHILADELPHIA DISTRICT COMMITTEE, symposium on wear of metals, Philadelphia, Pa., April 5.

ARKANSAS WATER WORKS CONFERENCE, annual conference, Fayetteville, Ark., April 12–14.

GREATER NEW YORK SAFETY COUNCIL, annual convention, New York City, April 13–15.

MICHIGAN ENGINEERING SOCIETY, annual meeting, Saginaw, Mich., April 15-17.

PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION, joint meeting with A.W.W.A., Four States Section, Philadelphia, Pa., April 22-23.

NORTH CAROLINA INDUSTRIAL SAFETY CONFERENCE, Winston-Salem, N. C., May 20–21.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, New York City, May 22.

Washington Highlights

By Paul Wooton

A report of the work done last year by the Civilian Conservation Corps, shows the CCC boys planted an average of more than 1,000,000 young trees and seedlings each working day since the corps was launched in April 1933. Total plantings reached a total of 1,035,000,000 by the first of the current year.

The U. S. Bureau of Public Roads on March 24 awarded to the U. S. Steel Products Corporation a contract for providing material and erecting the superstructures of three bridges on the Pan-American highway in Nicaragua. The largest of these will be a 120-ft. tied steel arch across the Rio Grande; the two others are 90-ft. steel pony trusses across the Esteli and Maderas Rivers.

The Senate has passed and sent to the House the Connally bill to extend the east front of the center of the Capitol Building in Washington. The bill carries two alternative plans, one for an extension of about 12 ft. and the other for an extension of about 32 ft. Expenditure of up to $4,000,000 is authorized in the bill, which was passed unanimously. Decision between the two plans would be made by a commission to be known as the Commission for the Extension and Completion of the United States Capitol.

The Coast and Geodetic Survey is "now making no progress at all" on its basic control survey. "All we can do is keep on with a little work which hardly keeps pace with the work destroyed each year." This was the statement made to the subcommittee on appropriations of the House of Representatives by Commander J. H. Hawley, assistant chief of the Coast and Geodetic Survey. He stated that about 77 per cent of the basic control surveys have been completed of a total of about 423,000 miles of leveling and triangulation. The cost of completing the work is estimated at $2,500,000 and the Survey has on hand for this work a total of about $100,000. At the present rate of expenditure, the Commander told the committee, it will take about 50 years to finish the task.

The House of Representatives on March 24 passed a bill requiring that, on federal building contracts exceeding $5,000, the general contractor shall submit with his bid a list of the subcontractors, materialmen and supply men whose services he intends to utilize, and providing penalties for failure to deal with them in the performance of the work.

The bill was amended before passage so as to require a similar penalty for failure to pay subcontractors, material men and supply men proportionately as payments are made to the contractor by the United States.

Purpose of the bill is to eliminate the practice of bid-shopping among subcontractors and material men after the award of a contract. The penalty may be remitted or refunded by the contracting agency upon a showing that a substitution for a listed subcontractor has been justified by a refusal to abide by a previous agreement on the part of the listed subcontractor. Small transactions amounting to $500 or less are exempted from the listing requirement.

Wilgus Gives Papers To Libraries

William J. Wilgus presents his professional records to New York Public Library and Engineering Societies Library

Col. William J. Wilgus recently presented his entire professional library to the New York City Public Library and the Engineering Societies Library in New York City. The records, comprising the engineering data of a great number of railroad and public projects and also records pertaining to Colonel Wilgus' service during the war as deputy director general of transportation of the A.E.F., have been divided between the two institutions on the principle that the military matter and matter pertaining to New York City projects has gone to the public library and the general engineering data and material on projects outside of New York City has gone to the Engineering Societies Library.

Colonel Wilgus has been active as a consulting engineer since 1908, and before that time held important positions in the engineering divisions of several railroads. As vice-president in charge of construction for the New York Central Railroad he supervised the planning and construction of Grand Central Terminal, the change from steam to electric power in the New York City zone, and the building of the Buffalo Union station.

In addition to a considerable collection of books and periodicals, Colonel Wilgus' library includes manuscripts and correspondence relating to Chicago Great Western Ry, Duluth & Iron Range Ry, and Duluth & Winnipeg matters prior to 1893. Documents relating to the New York Central and Hudson R.R. include the improvement, expansion and rehabilitation for heavy motive power on that system; construction of the terminal railway at Buffalo; electrification of the New York suburban zone; selection of the site for the Buffalo Union station; inception and construction of the Grand Central Terminal in New York City; and planning of the Detroit River tunnel.

There is much matter on projects in the New York city metropolitan area including the Narrows Tunnel project; the early period of the Port of New York Authority; the regional plan of New York City; the Holland Tunnel; the Art Commission of the City of New York, and other art activities; the super-highway between Jersey City and Newark; work relief in the city of New York; and many other activities in that region.

Many documents relate to miscellaneous projects throughout the country, among which are the Van Buren bridge across the St. Johns River; the Ashokan relocation of the Ulster and Delaware Railroad; valuation of many properties, including railroads, coal companies and similar organizations; and reports on railroads and other properties and various activities in behalf of bondholder's and stock holder's committees, states and municipalities. Other projects include the protection of the Mall at Washington, Morningside Park and the High Bridge aqueduct at New York City; the Green Mountain National Parkway project; and the re-erection of columns at the Parthenon, Athens.

Records of the American Expeditionary Force include reports, statistics, general orders, translations of French articles, maps, etc., as well as an unpublished history of "The Transportation Corps in the A.E.F.", compiled for G.H.Q. by Major John G. Melvin.

Bernard Heads River Division Of U. S. Weather Bureau

It is believed that the engineering profession will be interested in the appointment of an engineer to head the river and flood division of the Weather Bureau. Merrill Bernard has been appointed to succeed the late Montrose W. Hayes.

Mr. Bernard, who has conducted important researches on rainfall, runoff and stream flow and is the author of a number of reports and papers on these subjects, began the practice of engineering and surveying in 1911 in Texas and Louisiana, serving several parishes and drainage districts.

After the war, in which he served as a first lieutenant, Mr. Bernard practiced privately at Crowley, La. and New Orleans, specializing in work for drainage districts and in municipal drainage work. He later became associated with W. B. Gregory, practicing in the firm of Gregory & Bernard, New Orleans.

In 1936 Mr. Bernard became hydraulic engineer of watershed and hydrologic studies for the Soil Conservation Service at Washington

Washington Use Tax Upheld By U. S. Supreme Court

The Supreme Court has upheld a law of the state of Washington imposing a tax on goods used in the state and purchased outside the state, compensating for a state sales tax. The tax takes the form of a 2 per cent tax on the use of any article purchased at retail after the passage of the act, with an exemption for any goods on which a sales tax has been paid in Washington or any other state provided that the sales tax in a state other than Washington is at least as great as the 2 per cent Washington tax.

The Silas Mason Company, contractors on the Grand Coulee Dam, have used on the work supplies such as locomotives, cars, conveyors, pumps and trestle steel, bought at retail in other states, to the value of $921,000. Under the terms of the compensating tax they were ordered to pay a tax of $18,000, 2 per cent of the cost. The contractor obtained an injunction against the application of the tax from the U. S. District Court for the Eastern District of Washington.

In an appeal brought by the tax commission, the Supreme Court reversed the injunction and held that the tax was constitutional.

The contractor had claimed that the tax represented an unconstitutional tax by a state on interstate commerce and was, in effect, a tariff. The Supreme Court held that "the tax is not upon the operations of interstate commerce, but upon the privilege of use after commerce is at an end." It was held that the tax was not an attempt to discriminate by subterfuge against commerce from other states but was, in fact, compensation for the sales tax in the state of Washington in order to avoid any discrimination.

Personals

MARTIN R. RICE, engineer of Greenup County, Ky., has resigned to become connected with the WPA in the county.

G. G. HARE, city engineer of St. John, N.B., has been appointed director of public works, sewage, water and electrical inspection for that city.

FREDERICK ANDERSON has retired as chief hydrographer, Department of Transport, Ottawa, Can., after 45 years of service with the Dominion of Canada.

G. W. COWHAM has been promoted to the position of chief engineer of the municipal waterworks of Montgomery, Ala., to succeed the late T. M. McDonald.

SETH G. HESS has been named engineer for the Interstate Sanitation Commission to study the problem of pollution in waters of the metropolitan area around New York City.

ADOLPH F. BERNHARD, of New York, has retired after 50 years of service as an architectural engineer, the last 37 of which was spent with Jas. Gamble Rogers, New York.

RUSSELL HAMPTON, who has been connected for 13 years with the city engineering department at Chillicothe, Ohio, has been appointed service director of that city to succeed EDGAR B. HESS.

J. C. BISSETT of Dallas, Tex., formerly with the WPA at San Antonio, has been appointed associate regional engineer for WPA for the states of Arkansas and Tennessee with headquarters at New Orleans.

E. H. CONNOR has been made consulting engineer for the Missouri Valley Bridge & Iron Co., Leavenworth, Kans. He was formerly chief engineer of the firm, which position will now be filled by E. H. BARKMAN.

W. A. SELLS, formerly bridge inspector for the Kansas highway commission, has resigned to accept the position of meter superintendent of the Missouri Valley, Ia., district of the Iowa-Nebraska Light & Power Co.

LT.-COL. CHARLES F. WILLIAMS, district engineer, second Portland district and in charge of the Bonneville Dam construction, has been ordered to Ft. Belvoir, Va., effective in July.

HADLEY BALDWIN, Cincinnati, Ohio, has retired as special engineer for the C.C.C. & St. L. RR. after 43 years of service in the Big Four's engineering department. He was chief engineer of the road for eight years.

A. HOWARD PATTERSON, deputy administrator for WPA in South Carolina, has been re-appointed county engineer of Anderson County, S. C. He formerly held this position, but the office was temporarily abolished for lack of funds several years ago.

ALEXANDER H. KENIGSBERG has been assigned to the Kansas City district, U. S. Engineer Department, as assistant engineer. He was previously designing engineer for the Harza Engineering Co. on the Loup

River hydro plant, and before that was with Sargent & Lundy, Chicago, for ten years.

S. W. R. THOMPSON has been appointed engineer in oil and gas operations, U. S. Geological Survey, Taft, Calif. He was formerly with the U. S. Indian Service at Sells, Ariz.

JOHN PATTISON has been named county engineer for Kitsap, Wash., filling an office vacant for a year. He was promoted from the position of district engineer for the county, and had held the office of county engineer on a previous occasion.

Obituary

JAMES COOPER, 76, a civil engineer who in the past had served as city engineer of Lockland and Reading, Ohio, died in Cincinnati March 19. Mr. Cooper was a graduate of Cincinnati University.

JEAN K. LAWRENSON, 33, construction engineer for the Mountain States Telephone & Telegraph Co. in Denver died March 17. Mr. Lawrenson was a graduate of the University of Colorado.

WALTER B. BROOKS, JR., president of the Arundel-Brooks Concrete Corp., of Baltimore, Md., died March 25 in Baltimore. Mr. Brooks became president of the concrete corporation about five years ago.

I. P. MCCUSKER, aged 59, a civil engineer formerly connected with the Southern Railway in Birmingham, died March 16 in Washington, D. C., where he was employed in government service.

JOSEPH S. STANTON, 76, chief engineer of the Water Purification plant of the New Orleans Sewerage and Water Board, who had been connected with the board for 34 years, died recently in New Orleans.

A. P. ARMINGTON, president of the Euclid Road Machinery Co. of Cleveland, Ohio, died March 18 aboard the steamship President Adams while crossing the Pacific Ocean. Mr. Armington for the past year had given up the greater part of his business activities on account of ill health.

LEROY D. PEAVEY, at one time an assistant engineer with the American Bridge Co., later chief engineer of the H. P. Converse Co. of Boston, and recently president of the Babson statistical organization at Wellesley, Mass., died in Watertown, Mass., March 25, at the age of 61.

ROBERT WILCOX, a retired civil engineer formerly connected with the U. S. Engineers, died March 25, aged 70. At the time of his retirement six months ago he was in charge of maintenance of forts. Before his 20 years employment by the War Department he was an employee of the city of Chicago.

ERLE L. COPE, chief, Bureau of Building Inspection, San Francisco, Calif., died March 17 at the age of 54. Mr. Cope was a graduate of the University of California, class of 1906, and had had extensive experience as a structural engineer before his appointment to the city office in 1934. He was a past president of the Structural Engineers Association of Northern California.

LARGER AWARDS FOR THE WEEK

Fertilizer plant, Eastern States Farmers Exchange, Cambridge, Mass.	$500,000
Garage and warehouse, J. Shillito Company, Cincinnati, O.	$650,000
Plant, Coca-Cola Company, Dallas, Tex.	$800,000
Air-conditioning department store, Gimbel Brothers, Philadelphia, Pa.	$500,000
Gymnasium, University of North Carolina, Chapel Hill, N. C.	$504,000
Addition to Washington Irving High School, New York, N. Y.	$779,000
Contract No. 16, West Side Elevated Highway, New York, N. Y.	$1,014,000
Highways, Ohio	$860,000
Highways, Louisiana	$595,000
Highways, Michigan	$1,202,000
Highways, North Carolina	$655,000
Pipelines and other improvements to waterworks, Denver, Colo.	$515,000
Concrete drops and powerhouse substructures, Schedules 1, 2, 3 and 4, Boulder Canyon Project, Bureau of Reclamation, Yuma, Ariz.	$809,000
West Side Highway from 135th to 145th Streets, New York Central Railroad, New York, N. Y.	$1,000,000
Vehicular tunnel between Bingham and Copperfield: Copper Company of Salt Lake City, at Bingham, Utah.	$1,000,000

INDEX NUMBER

ENR Cost		1913 = 100	1926 = 100	ENR Volume = 100		1913 = 100	1926 = 100
Apr.,	1937	230.25	110.64	Mar.,	1937	147	64
Mar.,	1937	225.25	108.18	Feb.,	1937	181	79
Apr.,	1936	202.20	97.20	Mar.,	1936	160	70
1936 (Av.)		206.46	99.24	1936 (Av.)		185	81
1935 (Av.)		195.22	93.84	1935 (Av.)		135	58
1934 (Av.)		198.10	95.23	1934 (Av.)		114	50

CONTRACTS
(Thousands of Dollars)

	Weekly Average Apr. 1936	Weekly Average Prev. 4 Weeks	Week Apr. 1 1937
Fed Government.	$1,386	$4,506	$3,139
State and Municipal	24,965	14,234	14,019
Total public..	$26,351	$18,740	$17,158
Total private..	12,741	20,457	17,520
Week's' total...	**$39,092**	**$39,197**	**$34,678**

Cumulative to date:
1936 (14 weeks)....$644,306,000
1937 (13 weeks)....$553,740,000

Note: ***Engineering News-Record*** **reports waterworks and earthwork, reclamation or** waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the **volume of contracts and large force account** projects throughout the U. S. that are of **these minimum sizes or over.**

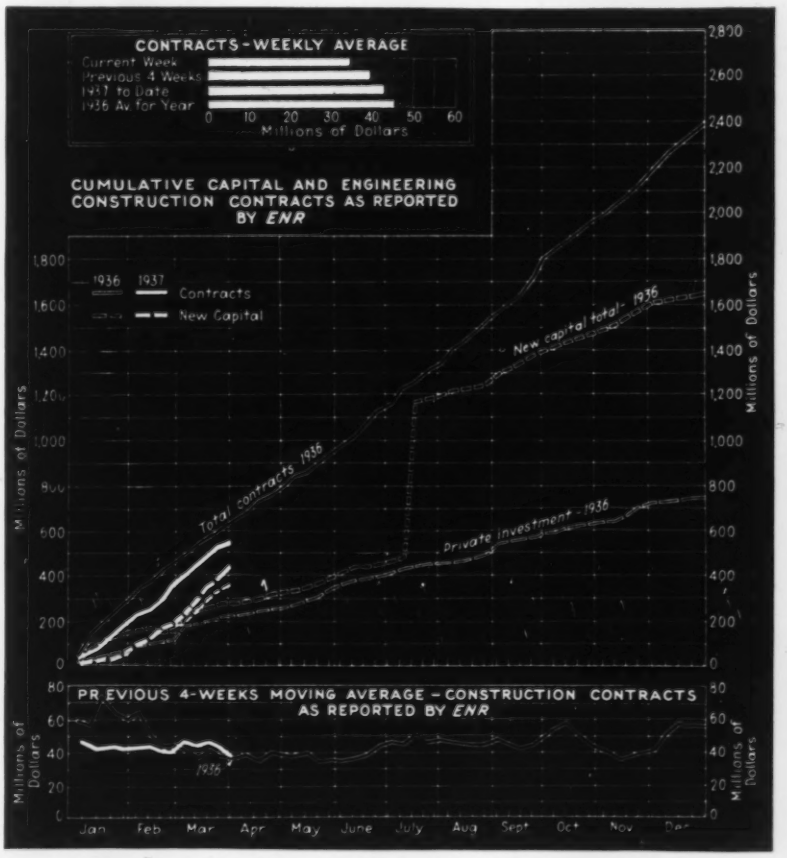
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1937	Week Apr. 1	Cumulative
Private investment	**$34,089**	**$365,014†**
State and municipal bonds	22,679	161,472†
Corporate securities ..	11,410	203,542
Federal financing	**$29,132**	**$75,701**
PWA non-federal Projects	.....	46,569
R.F.C. Loan	29,132	29,132
Total non-federal	**$63,221**	**$140,715**
Federal projects	.....	.....
Total	**$63,221**	**$140,715**

Cumulative to date:
1936 (14 weeks)....$304,282,000
1937 (13 weeks)....$440,715,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1937 to Date
1936 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936 1937
Contracts
New Capital
New capital total-1936
Total contracts 1936
Private investment-1936
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

BUSINESS SIDE OF CONSTRUCTION

March Gains 6 Per Cent Over 1936 Private Building Shows Wide Gains

MARCH engineering construction awards total $156,788,000, the highest dollar volume for any March since 1931. They include $81,827,000 in private contracts, and $74,961,000 in public, of which $18,023,000 is federal. This is a drop, however, below the February total, $189,197,000, which is composed of private, $103,745,000; and public, $85,452,000, including federal, $7,444,000. Corresponding values for last March are: total $147,697,000; private, $56,948,000; and public, $90,749,000, of which $7,316,000 is federal.

Private awards are 21 per cent below last month, but show a gain of 43 per cent over last year, while public contracts show losses of 12 per cent and 17 per cent compared with last month and last year. Private volume has exceeded public in three of the last four months.

March gains over February of 9 per cent in public building, 136 per cent in industrial building, 48 per cent in commercial building and 72 per cent in sewerage failed to offset the losses in streets and roads of 17 per cent; bridges, 22 per cent; waterworks, 20 per cent, earthwork and drainage, 49 per cent, and unclassified construction, 87 per cent, or a net loss of 17 per cent from last month.

Compared with last March, the weekly averages show increases in public building of 12 per cent; industrial building, 92 per cent; commercial building, 136 per cent, and waterworks, 13 per cent; while decreases are reported in streets and roads, 43 per cent; bridges, 40 per cent; sewerage, 17 per cent; earthwork and drainage, 3 per cent; and unclassified construction, 62 per cent; a net gain over last year of 6 per cent.

Territorially, Far West volume gains 18 per cent over last month and 98 per cent over last March. New England gains 56 per cent, Middle West, 24 per cent, and West of the Mississippi, 17 per cent over February. Compared with last year Middle Atlantic shows a 61 per cent increase.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD*, IN MARCH, 1937

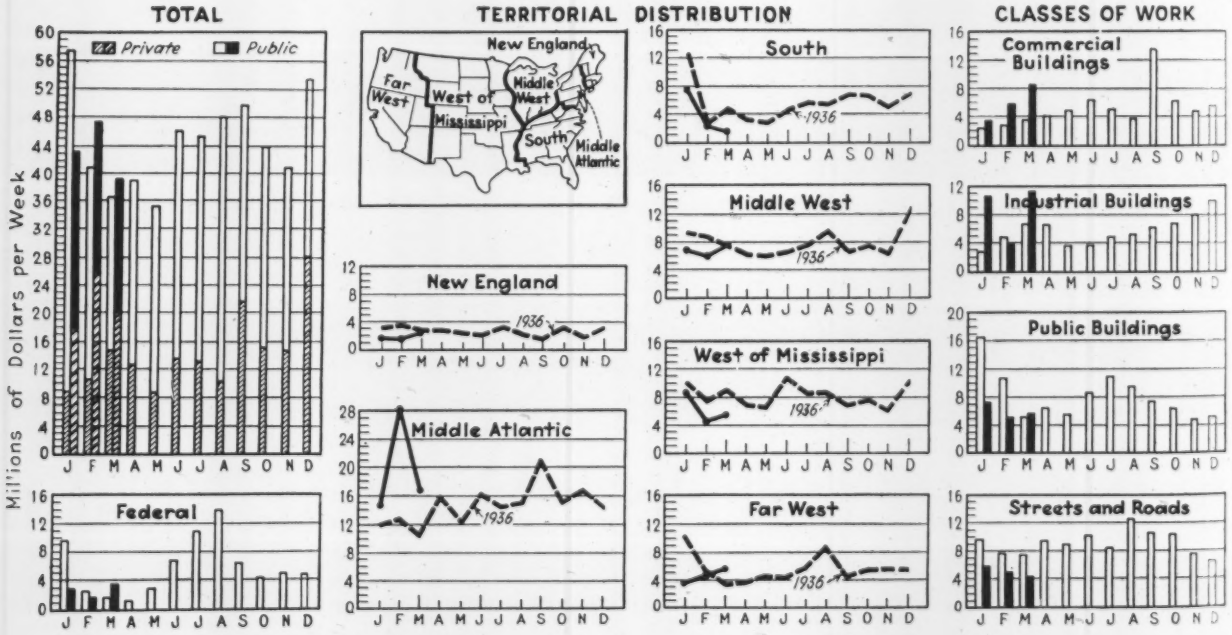
Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation*, $15,000; *other public works*, $25,000; *industrial buildings*, $40,000; *other buildings*, $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States March 1937	United States Three Months 1937	United States Three Months 1936	Canada
Public Works										
Waterworks	264	5,021	188	517	946	549	7,485	27,347	36,736	48
Sewerage	102	2,306	16	3,646	2,040	160	8,360	23,991	46,591	177
Bridges	312	2,735	574	1,531	975	966	7,093	26,474	42,862	...
Earthwork and waterways	122	288	24	126	2,777	1,118	4,455	22,170	52,972	81
Streets and roads	1,603	2,296	2,257	3,600	3,853	3,017	16,606	59,774	107,782	1,079
Buildings, public	750	8,930	699	5,730	2,061	5,052	23,222	73,636	144,488	647
Unclassified, public	194	2,895	2,263	1,259	912	217	7,740	28,846	27,000	249
Total public	3,347	24,561	6,001	16,409	13,564	11,079	74,961	262,238	458,431	2,280
Federal government (included in above classifications)	538	6,010	1,368	1,632	3,574	4,961	18,023	44,739	69,374	...
Private										
Bridges, private	...	...	...	...	32	...	32	2,144	1,509	...
Buildings, industrial	5,198	17,319	460	8,543	5,894	7,836	45,250	106,912	57,606	5,276
Buildings, commercial	1,320	24,385	319	4,849	1,358	2,460	34,691	75,863	37,253	1,245
Unclassified, private	110	470	115	456	563	200	1,854	71,905	45,944	...
Total private	6,628	42,174	894	13,848	7,787	10,496	81,827	256,824	142,312	6,511
Total Engineering Construction										
March, 1937 (4 weeks)	9,975	66,735	6,895	30,257	21,351	21,575	156,788	...	...	8,791
February, 1937 (4 weeks)	6,371	113,350	8,906	24,120	18,197	18,253	189,197	...	...	5,309
March, 1936 (4 weeks)	12,304	41,277	17,833	31,036	34,360	10,887	147,697	...	...	5,087
Three months, 1937	23,100	238,826	46,364	81,009	74,353	54,810	...	519,062	...	18,528
Three months, 1936	42,293	151,319	91,372	114,436	115,666	85,657	...	...	600,743	20,706

ENGINEERING CONSTRUCTION REPORTED BY *ENR* WEEKLY AVERAGES

□—1936 ■—1937

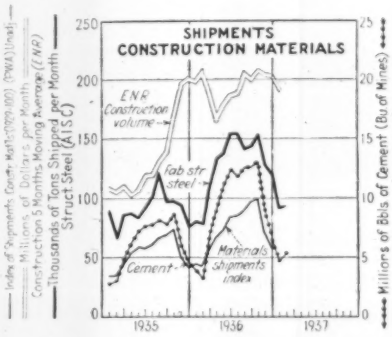


New Capital

New capital for construction purposes for March reached $194,040,000, a gain of 36 per cent over the total for February. The new financing consists of $127,129,000 in corporate security issues, $16,167,000 in state and municipal bonds and $50,744,000 in PWA allotments.

Materials

Portland Cement—The Portland cement industry in February, 1937, produced 5,837,000 barrels, shipped 5,163,000 barrels, and had 25,069,000 barrels in stock at the end of the month, according to reports of



the U. S. Bureau of Mines. Production and shipments of cement during the month showed increases of 68.0 per cent and 62.5 per cent, respectively, as compared with February last year.

The ratio of production to capacity for February is 29.6 per cent, compared to 30.4 per cent for January, and 16.4 per cent for February 1936.

Steel—The operating rate of steel companies having 97.7 per cent of the steel capacity of the industry averages 87.9 per cent for March, compared to 81.1 per cent for February, and 55.8 per cent for March 1936, according to the American Iron and Steel Institute.

The American Institute of Steel Construction reports new orders for February, 88,946 tons, dropped to 38 per cent of normal, and fell below the record for last February. The total fabricated structural steel sold in 1937 is 47 per cent of normal (normal being the annual average for the years 1928 through 1931).

Shipments of fabricated structural steel, 91,848 tons, were 39.3 per cent of normal, the same as January, and 10 points higher than last February.

Lumber—In March the lumber industry averaged 59 per cent of 1929 production, and 76 per cent of 1929 shipments, according to reports of the National Lumber Manufacturers Association. Production and shipments are the heaviest of the year and the highest since last October.

Lumber prices are unsettled, rising in some construction centers, falling in others. Increases are reported in Baltimore, Boston, Cleveland, Denver, Kansas City, Minneapolis, Montreal, New Orleans and San Francisco, while decreases are noted in Atlanta and St. Louis.

Building Permits

Permit values rose during February, due largely to the increase in permits issued in New York City. February values for the 215 cities reporting to Dun and Bradstreet, are $85,981,696. This exceeds the January total by 25.4 per cent, and the February, 1936, total by 66.8 per cent.

New York permits totalled $30,606,510 during the month, topping last month by 142.2 per cent, and February, 1936, by 189.2 per cent. With the exception of last June, this is the highest month for New York since August, 1931.

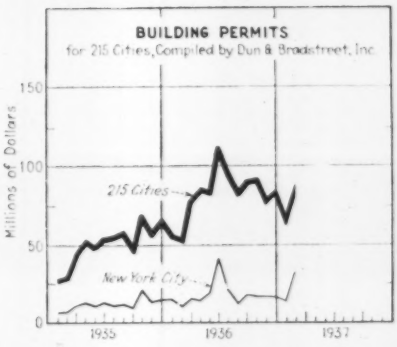
Labor

Employment in private building construction decreased 1.2 per cent during February, and payrolls fell 0.7 per cent, according to the Department of Labor, Bureau of Labor Statistics. These percentages are based on reports received from 8,409 building contractors employing 87,793 workers. Sharp increases in employment were shown in localities affected by the recent flood. Employment shows a gain of 54.6 per cent compared to last February, and payrolls show a gain of 88.4 per cent over the same period. Reports supplied by co-operating contractors relate to employees engaged in erecting, altering, and repairing private buildings and do not include projects financed by Public Works Administration or Reconstruction Finance Corporation funds or regular appropriations of the federal, state and local governments.

Employment on projects of the Works Program totalled 2,980,000 in February, a decrease of 55,000 from January. Of this total, 2,126,000 are employed on projects operated by the Works Progress Administration.

Approximately 172,000 workers are employed on construction projects financed by the Public Works Administration, a decrease of 30,000 compared with January. Payrolls amounted to more than $13,000,000.

The 20-cities wage average compiled



monthly by the *Engineering News-Record* is higher in the skilled group, due to increases in the structural iron workers' rate in Atlanta, and in all skilled building trades in Cleveland. Common labor averages still remain at their all-time high with no change during March.

A general 5 per cent wage increase for the building trade crafts is proposed by a conference board of three Sacramento, California, building trade organizations, as a substitute for demands of several crafts for increases of from 5 to 25 per cent. Bricklayers and plasterers are asking for a 25c. increase from their present rate of $1.50 per hour. Painters are asking for an additional 40c. per hour from the present rate of $1.10 per hour.

Efforts of the Department of Labor conciliator to mediate the dispute between building trade workers and the Great Lakes Construction Company of Chicago, on St. Louis' new post office were unsuccessful. A compromise offer was rejected by the workers. Construction workers asked an increase from 78¾c. to 87½c. per hour; hod carriers from 87½c. to $1.00; plasterer's helpers, from $1.06 to $1.15; carpenters and painters from $1.25 to $1.50; for the five day, 40 hour week.

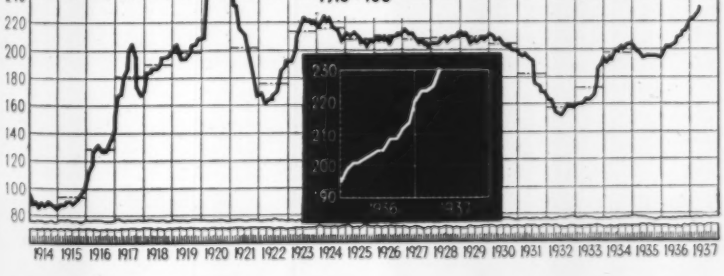
ENR Cost and Volume Index

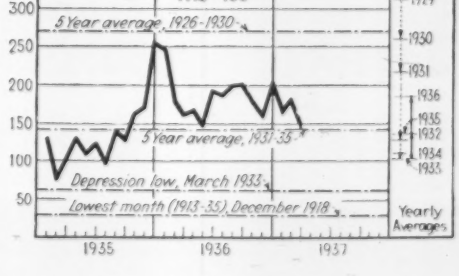
THE *Engineering News-Record* Construction Cost Index rises to 230.25 in April, the highest value since February, 1921. This rise is due to an increase in the steel price.

The *ENR* Volume Index for March is 147.

INDEX NUMBER

ENR Cost		1913 = 100	1926 = 100	ENR Volume		1913 = 100	1926 = 100
Apr.,	1937	230.25	110.64	Mar.,	1937	147	64
Mar.,	1937	225.25	108.18	Feb.,	1937	181	79
Apr.,	1936	202.20	97.20	Mar.,	1936	160	70
1936 (Av.)		206.46	99.24	1936	(Av.)	185	81
1935 (Av.)		195.22	93.84	1935	(Av.)	135	58
1934 (Av.)		198.10	95.23	1934	(Av.)	114	50





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Ready Mixed 1:2:4, 50c yd. or more, delivered
Atlanta	$2.83	$2.58	$2.50	$1.60	$1.60	$1.55	$1.65	$1.75	$1.65	$1.75	$8.00
Baltimore	2.31	2.06	1.86	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80	1.80	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.25*dl*	2.00*dl*	1.80*dl*	1.20	1.20	.85	1.40	1.40	....	....	7.00
Chicago	2.50	2.25	2.00	1.00	1.00	1.00	1.32	1.32	1.00	1.00	....
Cincinnati	2.53	2.28	2.08	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.40	2.15	....	1.40	1.40	1.10	1.60	1.60	1.75	1.75	7.40
Dallas	2.30	2.05	1.85	1.40	1.40	1.05	1.10	1.15	1.84	1.89	7.00
Denver	3.08	2.85	....	1.20	1.40	.90	....	....	....	....	....
Detroit	2.25	2.00	1.80	1.30	1.30	1.20	1.50	1.60	1.14‡	1.24‡	5.95
Kansas City	2.55	2.30	2.06	1.85	1.85	1.15	1.85	1.80	....	....	7.65
Los Angeles	2.32	2.12	....	1.20	1.20	.90	1.20	1.20	1.05*g*	1.05*g*	6.88
Minneapolis	2.80	....	2.35	1.00*p*	1.00*p*	.25*p*	1.00*p*	1.00*p*	....	....	7.00*f*
Montreal	....	2.48*S*	1.70	.80	.85	1.00	1.20‡	1.30‡	....	....	6.50
New Orleans	2.32	2.12	2.05	1.50	1.50	1.25	....	....	....	....	8.00
New York	2.50‡	2.20‡	....	1.10†*k*	1.10†*k*	.70†*k*	1.65†*k*	1.75†*k*	....	....	7.70
Philadelphia	2.55	2.30	2.10	1.45‡	1.55‡	1.15‡	2.40‡	2.55‡	1.00‡	1.00‡	8.00*f*
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	....	1.40‡	1.40‡	1.40‡	.75*p*	.75*p*	.65/.95§	.50/.85§	7.10
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.53
Seattle	2.95	2.70	....	1.33	1.33	1.33	2.25	2.25	....	....	7.50

*10c allowed for each returnable bag. † Per cu. yd. ‡ Delivered. § F.o.b. Granite City, Ill. *k* Barge lots alongside dock. *p* F.o.b. plant. *t* 5 tons or more. *v* Within 3-mi. from Public Square. *t* ton. *d* 5% discount for cash. *dl* 10% off for cash 10 days. *D* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *S* Sales tax included. *g* Crushed granite.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	1.70	1.65	Ironton, Ohio	$1.50	$1.45	Northampton, Pa.	1.65	1.60
Crestmore, Calif.	1.72	....	Iola, Kans.	1.70	1.65	North Birmingham, Ala.	$1.75	$1.70
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	La Salle, Ill.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Hannibal, Mo.	1.70	1.65	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hudson, N. Y.	1.75	1.70	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Independence, Kans.	1.70	1.65	Norfolk, Va.	1.70	1.65	Waco, Tex. (Plus 5c Tax in Texas)	1.75	1.70

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

Uniform carload lot cement price established last month lower peninsular Michigan.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over)			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over)			BRICK (Per M, in quantity)		LIME (Per ton, in paper)		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$63.20	$67.40	$126.30	$126.30	$147.40	$168.40	$12.75	$15.15	$19.50	$14.00	$14.00
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	20.00	14.00	25.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00§	1.75§	2.25*c*
Boston	86.25*l*	92.00*sl*	172.50*sl*	195.90*sl*	211.60*sl*	242.00*s*	16.00	19.00	20.00	15.50	3.50*t*
Chicago	66.00	70.40	132.00	174.30	214.40	245.00	10.20	11.20	15.00	12.80	12.00
Cincinnati	56.45	60.40	115.25	138.70	166.50	206.40	17.50	17.50	15.80	12.70	....
Cleveland	45.00	48.00	90.00	108.00	138.50	158.50	16.00	16.00	16.80*k*	14.40*k*	2.65*kp*
Dallas	59.00	62.00	125.00	149.00	155.00	177.00	9.50	24.00	19.00	16.00	.95*z*
Denver	78.70	88.00	141.50	160.65	196.00	225.50	11.50	15.00	30.00*k*	22.00*k*	25.00*z*
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	12.50	13.50	18.00	15.00	15.25
Kansas City	64.50	66.50	81.00*	125.50	159.75	186.25	14.00	24.00	18.90	12.40	10.35
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	....	19.70
Minneapolis	80.35	85.70	146.00	192.85	176.20*n*	245.20*n*	13.10	15.10*x*	21.00	16.00	19.00
Montreal	84.00*s*	96.00*s*	180.00*s*	....	273.00	....	15.50	20.75	23.50	17.00	11.00
New Orleans	72.00	68.00	130.00	162.00	180.00	230.00	14.00	....	18.30	14.00	....
New York	78.40	83.60	125.40*	193.30†	238.80†	295.60†	12.00	....	20.00	15.50	20.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	15.00	18.00	16.10	10.90	10.40
Pittsburgh	58.40	62.30	116.85	165.00	217.00	250.00	16.50	25.00	17.20	14.50	2.22*p*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	.55‡	.40‡	2.30*p*
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	.55§	.40§	2.05*p*
Seattle	110.00	130.00	210.00	110.00*y*	.....	.....	20.00*d*	20.00	30.00	20.00	28.60

*6x12x12 in. † F.o.b. Perth Amboy, N. J. ‡ Per sack. § Per bbl., 200 lbs. *p* Per bbl., 180 lbs. *q* Per bbl., 280-lb. *k* LCL. *d* less $1 cash 15 days. *c* Lump. *s* Smooth. *x* Selected common. *l* Carload lots delivered to job. *z* Per sack, 100 lbs. *n* - not load bearing *y* - 8 x 8 x 8 only

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80-300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OILS (Per gal.)		ASPHALT EMULSION (Per gal.)	
	Granite per M, lots of 50,000, 4x4x8 in.	Brick per M, 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Tank car	Drums
Atlanta	$75.00	$40.00	$2.25	$18.20‡	$23.41‡	$0.0728‡	$0.1049‡	.0768†‡	.1089†‡	$0.668‡	$0.0834	$0.0834	....
Baltimore	120.00	44.00	2.25	17.00	22.00	.075	.10	.09†	.125†	.....	.....	.....	.....
Birmingham	110.00	25.00	....	19.00	24.00	.0878	.1128	.10†	.137†	.....	.06	.....	.....
Boston	75.00	46.00	3.40	17.00	22.00	.07*e*	.095*e*	.094*e*	.125†*e*	.07*e*	.095*e*	.125*e*	....
Chicago	140.00	45.00	2.50	17.00	22.00	16.00	21.00	.07	.11	.045	.09	.135	....
Cincinnati	112.00	37.50	....	13.47	17.47	.12	.....	17.00	.....	.051	.078	....	....
Cleveland	100.00‡	32.50	3.00	18.00	21.75	.081	.099	.091	.061†	.06	.09	.099	....
Dallas	.....	32.50	....	19.00	22.75	.075	.10	20.00	28.00	.055	.085	.135	....
Detroit	.....	35.00	....	16.72*k*	21.97*k*	.....	.....	15.60	20.60	.055	.11	.15	....
Kansas City	.....	44.00	....	18.50	23.50	17.50¤	22.50¤	.077†	.107†	.057	.11	.15	....
Los Angeles	.....	50.00	....	10.00	15.16	11.00¤	15.16¤	11.00	.....	.042	.06	.12	....
Minneapolis	.....	.....	1.90*l*	21.70	26.70	.098	.137	21.85	34.65	.0638	.....	.....	....
Montreal	85.00*	60.00	3.62	14.00	20.00	.10	.13	.0975†	.01125†	.0675	.135	.165	....
New Orleans	100.00	32.00	....	15.20	18.75	.068	.095	.075†	.10†	.....	.0785	.11	....
New York	138.143§	65.00	2.75	17.00	22.00	.075	.10	.09†	.125†	.....	.075	.11	....
Philadelphia	120.00	52.00	....	15.00	20.00	.06	.085	.065†	.095†	.055	.07	.10	....
Pittsburgh	115.00	40.00	....	19.00	24.00	.077	.1125	.086†	.121†	.0675	.....	.....	....
St. Louis	115.120	37.00	....	19.00	24.00	.0775	.1075	.0825†	.1125†	.045	.09	.12	....
San Francisco	.....	70.00	....	12.00	18.00	12.00¤	18.00¤	12.50¤	23.00¤	.04	.0575	.117	....
Seattle	.....	40.00	....	25.50	25.50	17.00¤	23.00¤	15.00	.....	.03	.19	.20	....

Note—Paving asphalt, tank car or boat, f.o.b. Maurer, N.J., per ton, Bermudez, $25.00; Trinidad, $22.00. *Sales tax included. †Per gallon. ‡4½x6x5½ in. ¤Per ton. § 4x5x9 in. Av. *k* Mexican. ‡ Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *l* 2½ in. 6 to 8-lb. treatment. *e* F.o.b. Everett

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.40	$2.60	$3.35	$2.55		$42.50	$43.00	$42.00	$2.80	$3.15	$2.30	$4.35
Chicago	2.30	2.60	3.35	2.80	$2.70	42.50	43.00	42.00	2.80	3.15	2.30	4.35
Pittsburgh	2.25	2.45	3.20	2.75	2.60	42.50	43.00	42.00	2.80	3.15	2.30	4.35

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price: New billet	Rail steel	EXPANDED METAL LATH —Per 100 sq. yd., carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING —Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$3.65	$2.70	$2.50	$21.00	$23.00	$1.75	$1.31	$0.2848	$3.18
Baltimore	3.60	3.36	3.21	20.00	22.00	1.62	1.22	.2722	2.90
Boston	4.07	2.94	2.65	19.50†	21.50†	1.68	1.26	.2776	3.02
Chicago	2.30	2.60	2.45	22.00	25.00	1.61	1.22	.2713	2.70
Cincinnati	3.65	3.75	3.75	25.01	29.50	1.60	1.21	.2704	.....
Cleveland	3.89	3.45	3.15	21.50	23.50	1.59	1.20	.2686	.....
Dallas	2.45	2.65	2.60	.....	.....	1.86	1.38	.2947	2.85
Denver	4.48	4.15	4.00	22.00	25.00	1.87	1.38	.2965	.....
Detroit	3.95	3.385	3.235	20.75†	22.75†	1.62	1.22	.2722	2.865
Kansas City	4.25	3.19	3.04	22.50	24.50	1.72	1.29	.2821	3.12
Los Angeles	3.70	2.775	.....	23.00	27.50	1.89	1.40	.2983	3.90
Minneapolis	4.00	3.32	3.17	24.00	28.00	1.71	1.28	.2812	3.00§
Montreal	2.90	2.40	2.40	32.50	32.50	2.46	1.82	.253	2.80
New Orleans	.....	2.50	.....	21.00	23.00	1.76	1.31	.2857	.....
New York	3.97	2.98	2.83	18.50	20.50	1.65	1.24	.2749	2.88
Philadelphia	3.10	2.76	2.21	18.50	20.50	1.63	1.23	.2731	2.40
Pittsburgh	2.25‡	2.45‡	2.30‡	20.00‡	22.00‡	1.55	1.18	.2650	2.60
St. Louis	3.99	2.94	2.79	22/24.00	24/26.00	1.62	1.21	.2722	2.50
San Francisco	3.95	2.975	2.825	24.50	26.50	1.89	1.39	.2983	3.15
Seattle	3.55	3.00	.....	25.00	30.00	1.89	1.39	.2983	2.60

‡Base Mill Price plus switching charge. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. ††f.o.b. delivered

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry	WHITE LEAD Per 100 lb. in 500-lb. lots in oil	READY-MIXED PAINT Per gal., drums: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f. o. b. factory: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch, 350 lb. bbl., per ton
Atlanta	$11.00	$12.375	$1.62	$3.17	$1.40	$2.55	$2.25	$2.25	$.36	$28.00
Baltimore	10.75	12.00	1.45	2.25	1.70	2.16	3.25	3.25	.40	27.00
Birmingham	11.00	12.375	2.35	2.35	1.85	2.11	1.86	1.86	.36	22.00
Boston	10.75	12.00	1.80	2.50	.0475x	1.96	2.25‖	2.14‖	.45	20.00
Chicago	10.75	12.00	1.80	.....	.....	2.48	2.37	2.37	.43	33.00
Cincinnati	10.75	12.00	1.45	2.50	1.40	2.40	2.39‖	2.39‖	.36	21.00
Cleveland	10.75	12.00	1.90	2.65	1.40	1.85	1.81‖	1.81‖	.31	24.00
Dallas	11.00	12.75	1.80	2.10	.....	2.75‖	2.50‖	2.50‖	.60	60.00
Denver	11.25	12.50	2.55	.....	.....	2.65	4.00	4.00	.35	30.00
Detroit	10.75	12.00	1.65	2.40	1.40	2.40	2.65	2.50	.35	30.00
Kansas City	10.75	12.125	1.83	2.79	1.21	1.93	3.15	3.15	.25	24.50
Los Angeles	11.00	12.25	1.60	2.25	2.30	2.10	1.50	.....	.45	.....
Minneapolis	10.75	12.125	.....	.....	.....	1.85v	1.78‖v	1.78‖v	.29	23.80
Montreal	.....	8.20	2.00	4.75	2.40	2.50	1.60	1.83	.50	1.52§
New York	10.75	12.00	1.85	2.50	1.55	1.95	1.78‖	1.87‖	.026	23.00
Philadelphia	10.75	12.00	2.515	2.94	1.515	1.75	1.86‖	1.48‖	.29	25.00
Pittsburgh	10.75	12.00	1.05	1.95	.80	1.95	1.94‖	1.94	.34	25.00
St. Louis	10.75	12.00	1.60/1.85	2.40/2.45	1.40/1.70	1.83‖	2.57	2.57	.25	25.00
San Francisco	11.00	12.00	1.80	2.75	1.10–2.00	1.54	1.90	1.90	.325	22.00
Seattle	11.00	12.25	1.80	2.85	2.20	1.97	2.42	2.60	.60	28.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. ‖Per roll, 65 lb. xPer lb. vMinneapolis & vicinity.
Note: Red lead in oil 50c higher than white lead in oil. # Red lead prices change frequently due to pig lead price changes. zSales Tax included.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers List, Sept. 15, 1928 Single or Double Thickness: A quality	B quality	EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin: 40%	60%
Atlanta	83%	85%	$0.15	$0.16
Baltimore	88%	87%	.45	.16
Birmingham	88%	90%	.095	.11
Boston	87%	89%	.16	.175
Chicago	86%	87%	.105c	.12c
Cincinnati	89–10%	91–10%	.27	.29
Cleveland	85%	85%	.225	.235
Dallas	80%	80%	.16	.170
Denver	84%	85%	.16	.175
Detroit	87–10%	89–10%	.21	.24
Kansas City	84–10%	85–10%	.165	.18
Los Angeles	90%*	90–40%	.1725†	.1925†
Minneapolis	83%	84%	.16	.1675
Montreal	60–30%	70–5%	.18	.1925
New Orleans	85%	86%	.16	.185
New York	85%	87%	.215x	.23x
Philadelphia	85%	86%	.16	.175
Pittsburgh	86%	87%	.1525	.1675
St. Louis	89%	89%	.145	.165
San Francisco	78%	83%	.1475	.1625
Seattle	83%	86%	.1525	.1625

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B.
xManhattan only – other Boroughs $6 per trip. c carload lots.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00–35.00
Chlorine cylinders, per lb. delivered	.055
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb. dense	1.23
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	27.00
Sulphate of copper, in bbl., per 100-lb.	5.75

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.16	$0.195	$0.16	$0.19
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.20	.24	.18	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21	.255	.20½	.24½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.23	.265	.23½	.27½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.25	.275	.27½	.33½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.37	.415	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.40	.482	.....	.....

	RAILWAY TIES Prices f.o.b., per tie, for carload lots:	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.10	$1.50
	Pine, untreated	1.10	1.50
	Pine, creosoted	1.60	2.25
New York	Long-leaf sap pine, untreated	1.10	1.30
	Mixed oak, untreated	1.25	1.45
	White oak, untreated	.85	1.35
Birmingham	White oak, creosoted	1.50	1.70
	Southern pine, untreated *6 x 8 x 8' 6"	.55*	.70
	Southern pine, creosoted	1.10*	1.30
Chicago	White oak, untreated	1.25	1.55
	Oak, empty cell, creosoted	1.67	2.05
	Oak, zinc treated	1.55	1.90
	Southern pine, creosoted	1.50	1.95
Los Angeles	Fir, untreated	.64	1.38
	Fir, creosoted	.90	1.80
Philadelphia	Red oak, untreated	1.00	.....
	Red oak, creosoted	.....	2.10
St. Louis	White oak, untreated	1.07	1.48
	Red oak, untreated	1.05	1.48
	Red oak, creosoted	1.57	2.00
San Francisco	Sap pine or cypress, untreated	1.90	1.10
	Douglas fir, green, untreated	1.15	.63
	Douglas fir, empty cell, creosoted	1.14	2.45
Montreal	Birch or maple, untreated	.65	.75
	Birch or maple, creosoted	1.05	1.35

CURRENT PRICES OF CONSTRUCTION MATERIALS

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE Full standard weight. ‡			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot; delivered, ASTM C 13-35 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots., f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-35 12 in.	24 in.	1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$50.00	0.26dl	$0.468dl	$1.629	$4.501	$35.00	$128.00	$0.45	$1.625	44.5	35.5	42	32.0
Baltimore	53.50	.28	.54	2.38	7.18	110.00	170.00	.40	1.60				
Birmingham	46.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	64.5	55.5	62	52.5
Boston	53.50	.224	.432	1.98	5.845	99.00	153.00	.43	2.40				
Chicago	54.50	.24	.54	2.25	5.125	100.00	150.00	.38	1.48	58.75	48.75	55.625	45
Cincinnati	53.00	.263	.3915	1.71	5.2275	69.00	108.00	.40	1.40	58.75	48.75	55.625	45.00
Cleveland	54.50	.182	.351	1.53	4.8175	69.00	108.00	.32	1.64	56	44.5	51.5	40.5
Dallas	58.00	.40				160.00	260.00	.46	1.57	69.5	61.5	67	58.5
Denver	66.00	.27‡	.47‡	1.98‡		105.00	180.00			44	33	41	24
Detroit	54.50	.203	.3915	1.71	5.2375	82.00	136.00	.35	1.20	59.3	49.3	56.1	45.5
Kansas City	54.60	.30	.54	2.16	5.00	120.00	140.00	.45	1.50	55	45	52.0	41.5
Los Angeles	54.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	57.1	48.1	54.6	44.9
Minneapolis	56.50	.24‡	.432‡	1.728‡	4.60‡			.65	1.75				
Montreal	55.00	.33‡	.59‡	2.04‡		82.00	134.00	.51	2.04				
New Orleans	52.00	.26	.468	1.69				.45	1.65				
New York	53.00	.24	.49	2.20	6.10			.55	2.00	57.50z	47.50z	54.375z	43.75z
Philadelphia	50.00	.196	.378	1.755	5.33	100.00	150.00	.54	1.80	52.37z	41.35z	53.39z	42.57z
Pittsburgh	56.00	.168‡	.324‡	1.35‡	4.92‡	52.00	81.00	.85c	2.00	64.5	55.0	62	52.5
St. Louis	47.00	.28	.504	2.016	3.96	85.00	170.00	.80	2.00	51.125	39.875	48	36.125
San Francisco	54.00	.29L	.522L	2.088L	5.67L	103.50	172.50	.45	2.20	53	44	47.5	37
Seattle	55.50	.420	.63†	3.06†	7.55†	85.00	200.00†	.50†	1.60	65.80	57.25	66.75	56.30

*b. & s. class B and heavier, C. L lots, 200 tons and over. Burlington, N. J. (base) $45.00. Gas pipe and class A, $3 per ton additional. 4 in., $3 per ton additional. 30 in. and larger usually $2 per ton less.

‡ Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in. 11½ c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½ c.; 4 in., $1.09; 6 in., $1.92.

k 2½ to 3 in. z Resale price to consumer, car load lots shipped from mill.

‡ f.o.b. † Less 30% in C/L Lots. c Concrete Culvert pipe reinforced. d Double strength. l List to dealers. L list. t Sales & municipal taxes extra.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

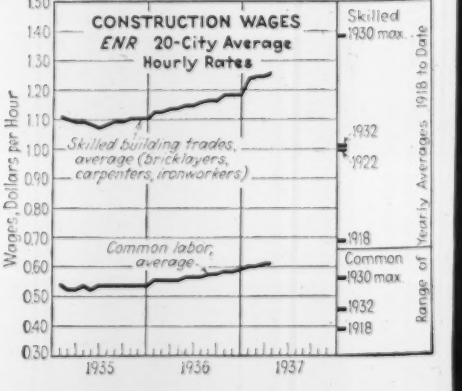
	SHORT LEAF YELLOW PINE AND DOUGLAS FIR—All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face). All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note)	
	1x6,S	1x8,S	2x4,S	2x6,S	2x8,S	2x10,S	3x12,R	6x12,R	12x12,R	2x12,R	12x12,R	⅝"	¾"
Atlanta	**$22.00**	**$22.00**	**$22.00**	**$22.00**	**$22.00**	**$24.00**	**$28.00**	.....	.....	$50.00	$50.00	$16.80	$20.50
Baltimore	**28.00**	**29.00**	**31.50**	**31.50**	**32.50**	**34.00**	**40.00**	.....	.....	62.00	62.00	16.45W	20.05W
	34.00	*34.00*	*34.50*	*32.50*	*32.50*	*33.00*	*36.00*	*$36.00*	*$34.50*	.....	.....	.....	.....
Birmingham	**26.00**	**26.00**	**27.00**	**26.00**	**26.50**	**28.00**	**38.00**	**37.00**	**37.00**	.....	.....	15.55	18.95
†	28.00	28.00	32.00	30.00	33.00	35.00	54.00	.....	.....	55.00	53.00	.....	.....
Boston	35.00[2]	35.00[2]	40.00[3]	40.00[3]	55.00[4]	65.00[4]	80.00[4]	.....	.....	80.00	80.00	16.45W	20.05W
	35.00	*35.00*	*40.00*	*40.00*	*40.00*	*43.00*	*45.00*	*50.00*	*50.00*	.....	.....	.....	.....
Chicago	**35.00**	**35.00**	**36.00**	**36.00**	**36.00**	**36.00**	**50.00**	.....	.....	60.00	60.00	12.45	15.15
Cincinnati	**25.50**	**25.50**	**25.50**	**24.50**	**25.50**	**28.50**	**39.50**	.....	.....	41.00	44.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	*43.75*	*43.75*	*43.75*	.....	.....	.....	.....
Cleveland	**35.00**	**37.00**	**43.00**	**37.00**	**41.00**	**43.00**	**54.00**	*49.00*	*48.75*	57.00	69.00[8]	15.55	18.95
Dallas	**33.50**	**35.00**	**38.50**	**32.50**	**35.00**	**36.50**	**46.50**	**51.50**	**66.00**	42.50	85.00	13.15	16.05
Denver	*46.00*	**46.00**[4]	*60.00*	*49.00*	*49.00*	*52.00*	*62.00*	*67.50*	*67.50*	.....	.....	9.35	11.35
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**35.00**	**37.50**	**44.00**	.....	.....	32.00	44.00	15.55	18.95
	.....	.....	.....	.....	.....	.....	*47.50*	*47.50*	*50.00*	40.00	50.00	.....	.....
Kansas City	**32.00**	**32.00**	**31.50**	**30.50**	**30.50**	**31.50**	**40.00**	.....	.....	56.00	62.00	11.45	13.95
	29.00	*29.00*	*32.00*	*32.00*	*32.00*	*33.00*	*35.00*	*40.00*	*40.00*	.....	.....	.....	.....
Los Angeles....†	*40.00*	*39.00*	*40.00*	*39.00*	*41.00*	*41.00*	*48.00*	*54.00*	*49.00*	.....	.....	8.90WX	10.80WX
Minneapolis..*‡	**54.00**[6]	**54.00**[6]										11.45	13.95
*	*45.00*	*45.00*	*48.00*	*46.00*	*46.00*	*47.00*	*65.00*	*67.00*	*67.00*	47.00	.....	.....	.....
Montreal .....[7]	50.00	50.00	*54.00*	52.00	53.00	63.00							
	44.50	*44.50*	*45.00*	*45.00*	*45.00*	*46.50*	*47.00*	*47.00*	*47.00*	87.00	81.00	.....	.....
New Orleans	**30.00**	**31.00**	**40.00**	**30.00**	**35.00**	**35.00**	**45.00**	.....	.....	48.00	55.00	13.15	16.05
	28.95	*31.50*	*33.90*	*29.50*	*32.90*	*34.00*	*38.00*	.....	.....				
New York.....*	**37.50**	**39.00**	**37.50**	**39.00**	**39.00**	**42.00**	**47.50**	.....	.....	77.50	80.00	16.45W	20.05W
*	.....	.....	*47.50*	*47.50*	*47.50*	*47.50*	*52.00*	*57.50*	*57.50*	.....	.....	.....	.....
Philadelphia	**28.50**	**28.50**	**28.50**	**29.00**	**29.50**	**30.50**	**38.50**	.....	.....	60.00	60.00	16.45W	20.05W
	45.00	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*42.00*	*42.00*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	[2]**2.00**	**45.65**	**46.90**	**59.70**	.....	.....	57.50	57.50	16.20	19.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis.....*§	**34.00**	**35.50**	**33.50**	**32.50**	**33.50**	**35.00**	**49.50**	*55.00*	*55.00*	72.50	71.50	13.15	16.05
San Francisco. §	*26.50*	*22.00*	*27.00*	*22.50*	*26.50*	*22.50*	*29.00*	*22.00*	*22.00*	.....	.....	6.95W	8.50W
Seattle	*16.50*	*16.50*	*16.50*	*15.50*	*15.50*	*15.50*	*21.00*	*20.00*	*20.00*	.....	.....	0.00	0.00

§ S4S. R Rough. * All prices delivered. † Yard prices. ‡ Contractors in Minneapolis & St. Paul get 10% disc. from list. § 5M ft. or less s At ship's tackle. d10% Disc. taken off. 1 Long leaf. 2 Roofers N.C. Pine. 3Spruce. 4Native. 5 Western Pine. 7 Pine. 8 Norway Pine. 9 Dec. prices, Jan. prices not available due to strike. Bold face type, Southern Pine. Italics, Douglas Fir.

Note: Special concrete form grade Fir Plywood, 4'x8' panels, 5-ply, sanded 2 sides, water resistant glue, car load lots, delivered per 1000 sq. ft. surface. Base price—Seattle: ⅝", $70.125; ¾", $80.025. For other centers add rail freight increment from table for proper size. Add: for form oil treatment $2.50 per M. sq.ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment $10.00 per M.

W Lower rate by water shipment. X 50,000 lb. minimum.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$0.40/1.00	$1.00/1.25	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.25	1.10	1.375	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.25	1.125	1.00	.30/.40†	.30/.40†
Boston	1.50	.90/1.375	1.375	1.00/1.375	1.625	.60/.80	60/.85
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.80/1.375	.45	.45
Chicago	1.50	1.50	1.50	1.50	1.50	.95	.95
Cleveland	1.625	1.375	1.50	1.375	1.50	.825	.825
Dallas	1.25	1.00	1.00	1.00	1.25	.40	.40
Denver	1.25	1.25	1.25	.....	.....	.625	.625
Detroit	1.25	1.00	1.25	1.25	1.25	.60/.75	.60/75
Kansas City	1.325	1.25	1.25	1.25	1.45	.80	.45/.50
Los Angeles	1.10	1.10	1.125	1.125	1.25	.60	.60
Minneapolis	1.25	1.10	1.25	1.25	1.35	.75	.75
New Orleans	1.00	.75/1.00	1.00 1.25	1.00	1.00	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.825	.50/.80
Philadelphia	1.50	1.00	1.375	1.50	1.375	.40/.50	.40/.50
Pittsburgh	1.50	1.25	1.375	1.00	1.50	.70	.50
St. Louis	1.50	1.25	1.75	1.57 1.75	1.50	.875	.35/.875
San Francisco	1.50	1.125	1.375	1.125	1.50	.75	.60
Seattle	1.50	1.125	1.25	1.25	1.50	.80	.80
Montreal	.70	60	.65	.55	.70	.40	.35

Skilled Avg.: (Bricklayers, Carpenters, Ironworkers) $1.258; Common Avg. $0.612. † PWA.